ACT STATE EMERGENCY SERVICE

NAVIGATE IN URBAN AND RURAL ENVIRONMENTS

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Australian Capital Territory Emergency Services Authority

Learning Manual

Navigate in Urban and Rural Environments

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Introduction

Read through this learning manual carefully. The skills and knowledge covered in each session will help you to develop competence in this unit. Talk to your Trainer/Assessor and agree on how to organise your training. Work through all the information and complete the activities in each session. They will support you and show you the correct way to do things.

Listen, take notes, ask questions and practice your new skills on-the-job or in a simulated workplace environment. Make sure you practice your new skills regularly. That way you will improve both your confidence and performance.

Ask your Trainer/Assessor (when you are ready) to watch you perform the activities outlined in this learning manual, and ask for feedback on your progress.

Acknowledgements

The Emergency Service Authority (ESA) acknowledges the assistance of the Australian National Training Authority and Fire & Emergency Services Authority of Western Australia who provided much of the material used in this publication. Several of the images in this document have been kindly supplied by “TASMAP”.

Learning Activities

There are a number of Learning Activities to help you develop the skills and knowledge you need to achieve competence in this course. They may ask you to answer questions, discuss issues with your Trainer/Assessor or find information. Space is provided for written answers to exercises and activities, but please use additional pages if you need them. There are also some SELF CHECK tables throughout the document, which will ask a series of questions to assist you. They will ensure you feel confident and have a good understanding of the learning guide.

Throughout the learning manual you will see this symbol, which will indicate an activity has been planned to assist your learning.

ACTIVITY

Participant's Notes

These notes are to be read in conjunction with the ESA Code of Practice, which is available from the Staff Development & Training Section. During this course, participants will be trained and assessed in navigation skills for urban and rural environments.

Who Should Complete the Course?

Prior to commencing the course, participants must be registered with an ESA brigade and be deemed competent at the base level for ACT Rural Fire Service (ACTRFS) or ACT State Emergency Service (ACTSES).

This course assumes that participants have little prior knowledge or experience of navigation. Depending on the individual's previous life skills, it may be possible to accelerate through this course. However, care should be taken to ensure that all participants understand the concepts and can demonstrate the skills required. This means that some participants may require further training and assessment. For more experienced personnel, it is recommended that you look at the assessment workbook then the training manual and work back to identify what skills they may need to refresh or include to be able to complete the assessment.

Relationship to Competency Standards

This Learning Manual covers all the elements of the Public Safety Unit of Competence PUAOPE003B Navigate in Urban and Rural Environments. This competency is placed at the Advanced Operator level for ACTSES and the Advanced Fire Fighter level for ACTRFS. At the beginning of each section the standard that needs to be reached to achieve the competency is provided, these are called elements and performance criteria. These make up the competency standard and outline what you will be assessed against.

Pre-requisites
The pre-requisite for the ACTRFS is to have been deemed competent at the Bushfire Fighter level for 2 years and for the SES to be deemed competent at the Operator level for 2 years.

Bushfire Fighter
- Work effectively in a public safety organisation
- Work in a team
- Operate communications systems and equipment
- Communicate in the workplace
- Follow defined OH&S practices and procedures
- Prevent injury
- Respond to wildfire

Operator
- Work safely on an incident ground
- Have an appreciation of emergency situations
- Use various techniques to neutralise threats and hazards,
- Use and care for Emergency Service equipment
- Use and care for communications equipment
- Work in a team

Access and Equity

The Course Coordinator and Trainers/Assessors will ensure that all participants have equitable access to the benefits of training and assessment.

Recognition of Prior Learning

If you feel that you have completed the appropriate training or have sufficient experience to meet the required skills/competencies outlined in the training program for PUAOPE003A Navigate in Urban and Rural Environments, see your training officer. They will arrange for you to participate in an RPL/RCC process.

To be granted competence, what do I need to do?

- Demonstrate your skills and knowledge to a workplace assessor through an assessment process, or
- Produce certificates or evidence of training courses you have completed previously.

Health and Safety

The Course Coordinator, Trainers/Assessors and Course Participants must be made aware of relevant workplace health and safety issues in all situations and are required to demonstrate safe working practices at all times. A Safety Advisor may be appointed depending on the nature of the activities, and is to be familiar with his/her duties.

Learning Manual

This Learning Manual will assist you throughout the course (please ensure that you bring it with you). You are strongly advised to study it as part of pre-course reading. Unless otherwise directed, you are not required to complete any of the activities provided in this workbook prior to the commencement of the course.

Certification Documents

Participants who are deemed competent at the completion of this nationally recognised ESA training programme will be issued with a Statement of Attainment, recognising their competency for PUAOPE003A Navigate in Urban and Rural Environments.

SECTION ONE

MAP READING

Element	Performance Criteria
1. Determine current location, destination and resources.	1.1 Incident and/or task location requirements are obtained. 1.2 Relevant maps and navigation equipment are gathered and checked. 1.3 Cartographic information and navigation techniques are applied to plot positions on a map and determine current location and destination within accepted tolerances.

SESSION 1 - MAP CHARACTERISTICS

Learning Outcomes for this session:

- Outline aims of map reading and navigation
- Explain how to care for the map
- Locate positions on a map (Street Directory)
- List the various types of maps that people would be required to navigate from
- Identify various types of maps and their purpose
- Identify the marginal information on a map
- Describe common map symbols

WHAT IS MAP READING AND NAVIGATION?

The aims of map reading and navigation are to:

- Enable you to find your way around the country and city area and to recognise features on the ground and on the map;
- Enable you to understand the information on the map so that you can picture the ground and its possibilities and limitations, even though you have not seen them, and;
- Assist you to transmit information quickly and accurately.

Why Should You Acquire This Skill?

Map reading and navigation is an integral part of any ESA response. As an ESA team member, at any time you must be able to:

- Determine your location (where you are now), destination (where you are going) and resources (what you have or will need to get there);
- Determine and plan a safe route (how you will get there) whether through bush or by roads;
- Navigate to the destination (get there), which may require you to re-plan your route as you experience changes in the environment (change course) and;
- Report and keep records of your journey.

The skill will allow you to extract information shown on a map, including the relationship of the ground to the map and map to ground. In addition to making full use of a map, you must be able to give and read grid references, take compass bearings and measure distance. All of these will be covered in this learner's guide.

Where do I apply this skill?

In ESA procedures, a briefing is normally given to the members by the Commander or the Captain of the brigade stating the team's/crew role and its area of operation. Tasks are assigned to members of the team/brigade, one of them being navigator. Once assigned, the navigator procures the correct equipment (e.g. maps, compasses etc.) to enable them to do their job. The navigator should commence their task immediately by preparing a route plan prior to the team/brigade moving out, and should navigate from the moment the team/brigade leaves the base of operations until the team/brigade reaches its destination.

It is important that the navigator keeps a written record of the route and other necessary information in case the situation changes and an alteration of course become necessary. Likewise, all records regarding the operation should be filed and kept should a Police inquiry or coronial inquest into the operation ensue.

Using Your Map Reading Skills

ESA Units respond to emergencies in all areas – urban, rural and in remote locations. Therefore you might be required to:

- Map the effects of a wind storm or flood damage
- Navigate to a remote fire
- Navigate in difficult terrain
- Plan roadblocks and evacuation routes
- Plan for and navigate during a land search and/or rescue
- Plan/set up field or support headquarters or find an appropriate place for a landing pad.

MAP READING

What is a map?

A map is a plan of the ground, a picture of the earth's surface, drawn at a certain date.

It must therefore be realised that the older the map, the less reliable its information will be.

Man-made features may appear or disappear, but what will rarely change is the earth's physical features. Always look for the date the map was compiled to determine its accuracy, and therefore its reliability.

Care of the Map

Maps are valuable documents and should be treated with care to prevent damage.

This generally occurs when users open them fully out in the open air or in moving vehicles. A slight breeze can catch them and start small tears that quickly spread.

A map should be folded with the aim of reducing it to a size convenient for carrying and also to ensure that a reasonably large area is available for study when two folds are opened like a book.

Others ways of protecting maps are:

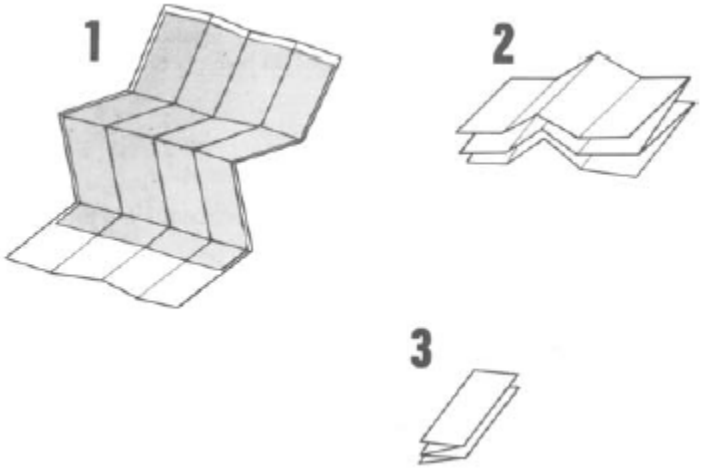
1. Laminate maps – ideal for office use
2. Roll maps and secure in sturdy cylinders when not in use
3. Use a map case when working in the field
4. Use soft leaded pencils only and soft rubber erasers
5. Use a clear plastic overlay – again, ideal for office use

To fold a map:

1. Fold it in half long-ways with the map detail outwards
2. Fold it in half the other way, as in Diagram 1
3. Fold the outer sides to the centre, concertina fashion

This produces a long narrow exposure of map detail, as in a road map.

Note: To avoid deterioration at the creases, clear tape can be fixed on the blank side to provide greater stability to the paper during field use.



To fold a map so it will fit neatly into a map case and expose a wider section of the map, the opposite applies:

1. Fold the map so the long sides are brought together, map detail facing outwards
2. Fold the map in half lengthwise
3. Fold the outer edges to the centre

Activity 1

You are assigned the role of navigator for a Unit/Brigade for an operational activity in the suburbs. What information and equipment will you need to gather?

_____
_____
_____
_____

Activity 2

You are assigned the role of navigator for a search in rugged terrain. What information and equipment will you need to gather?

_____
_____
_____

Activity 3

List ways you can prolong the life of a map:

_____
_____
_____

TYPES OF MAPS

There are many different types of maps used for navigation purposes. Topographic maps and street directories are the most common used for ESA activities, while topographic and cadastral, or a combination of both, are used for firefighting. An understanding of how to read each type of map is recommended for those working in these fields.

Type of Maps:

1. UBD Street Directories

2. Topographic Maps

3. Cadastral Maps (Block & Section)

4. ACT Emergency Service Bureau Operational Atlas - Topographic/Cadastral

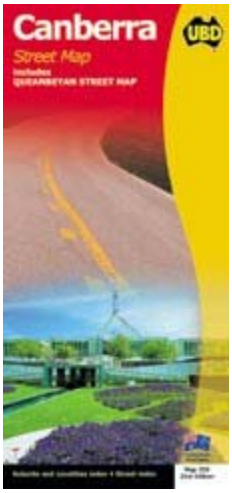
5. Land Management Agency specific maps

6. Rural Addressing (Corio System)

7. Operational maps

UBD Street Directories

All ESA vehicles should contain a Street Directory; the standard for ACTRFS & ACTSES personnel is the UBD Street Directory. It is vital that all ESA personnel are able to read and interpret street directories so they are able to navigate their vehicle to the incident site. Most ESA vehicles have a navigator who sits alongside the driver. Their role is to select the most appropriate and efficient route to the incident site.



To provide consistency when providing grid references, it is recommended that Units/Brigades use the latest UBD Directory. Most street directories have information relating to the location of suburbs and street names. All of this information is found in the index, located in the front of the street directory. It is vital when locating a street name that you identify the correct spelling of the street name because some have similar spelling and you may find yourself in the wrong street. Also ensure that the suburb is correct, as some street names are used several times, but in separate suburbs. Not all letters are used in page references as O and I are missing. Each grid cell is 250m by 250m and is tied into the UTM grid (AMG66).

Locating a Street Name and Suburb

To find a street, look in the index, identify the street name and suburb in the alphabetical listing. Note the map number and reference (letter and number) and turn to the appropriate page. Trace down from the letter on top of the page, then across from the number at the side of the page, the street is located inside the square where the letter and number reference intersect. Street directory map symbols are usually located near the index. If a road passes through more than one square then you may need to ensure this information is passed on.

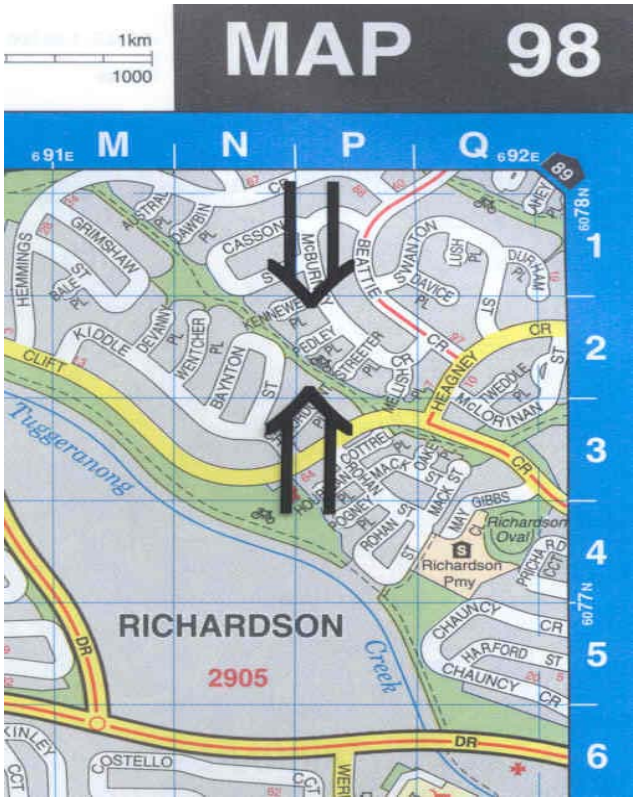
To locate Pedley Place Richardson go to the Street Index.

1. Find Pedley Place Richardson (The UBD reference is Map 98, P 2.)
2. Turn to Map 98.
3. Find P along the top.
4. Search down between the grid lines either side of P
5. Go down until you reach the gridlines above and below the number 2.
6.

This will give you the general vicinity of Pedley Place.

At each edge there is a tab, which indicates the adjoining map.

The map number on the corner refers to the diagonally adjacent map.



Activity 4

Using a UBD Street Directory, indicate the Map Number and Reference for the street indicated by your Trainer.
Map Number: _____ Reference: _____

Activity 5

The Trainer will provide you with a Map Number and Reference, what is the name of the street?

_____

_____

Activity 6

Using the index at the back of a Street Directory, locate the Map Number and the reference (letter and number) for the following locations:

Location	Map Number	Reference (Letter and number)
Local Post Office		
Your Local Shed/Depot		
Location of the nearest park/oval		
Nearest Roundabout to your Unit / Brigade HQ		

Activity 7

Locate the Map Number and the reference (letter and number) for the locations listed below, using the UBD 2003 Edition, or as set by your Trainer:

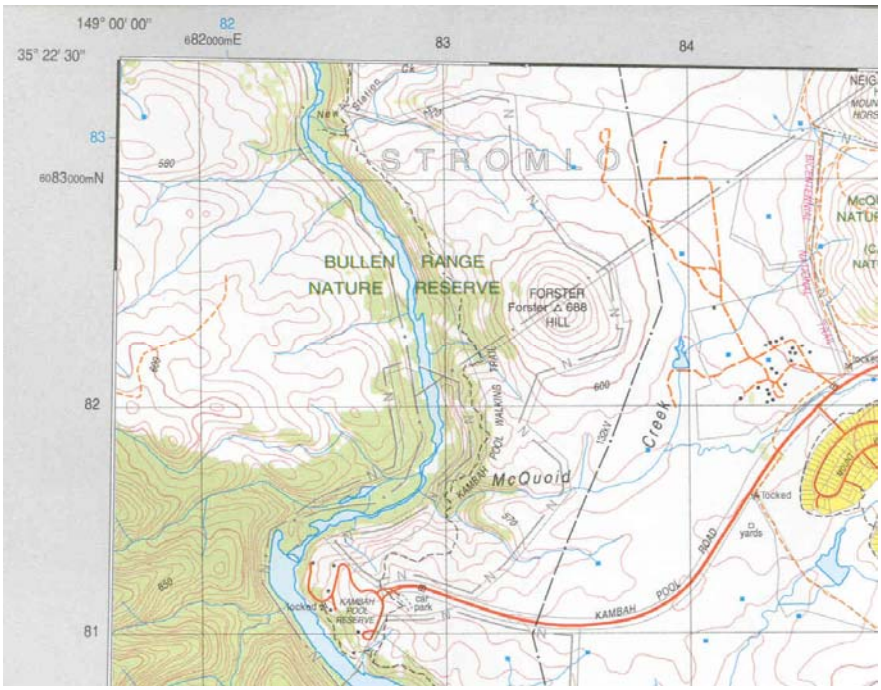
Location	Map Number	Reference (letter and number)
Hirst Place Giralang		
Maltby Circuit Wanniassa		
Your Street, Your Suburb		

Topographic Map

Topographic maps show topography and landforms and also show natural features such as hills, rivers, forests and swamps. Built features are also shown, such as roads, buildings, dams and property lines.

Each grid square is usually one kilometre square, regardless of scale, and covers 100 hectare.

The majority of this Learning Manual deals with how to read and navigate using topographic maps.



Cadastral Maps (Canberra by Suburbs)

Cadastral maps are based on land ownership information. In the days of "staking claims", a cadastral survey followed occupation and the map was drawn to show which property belonged to whom. Today, the term is used to refer to maps, which show subdivision details. The block and section maps are cadastral maps. These maps show the subdivision of land, with each area identified by its own individual number (e.g. Block & Section number). In most cases, the boundary of the property is actually the fence line. The "Canberra by Suburbs" is a large-scale map series, which shows every block of land in urban areas and provides other detailed information. Every block of land is shown with a street address.

The advantages of the Canberra by Suburbs maps over the street directories are, the larger scale means that individual blocks and house numbers can be shown, these may be helpful where the house number sequence is not consecutive, and where there are battle-axe blocks. They will also show proposed developments.

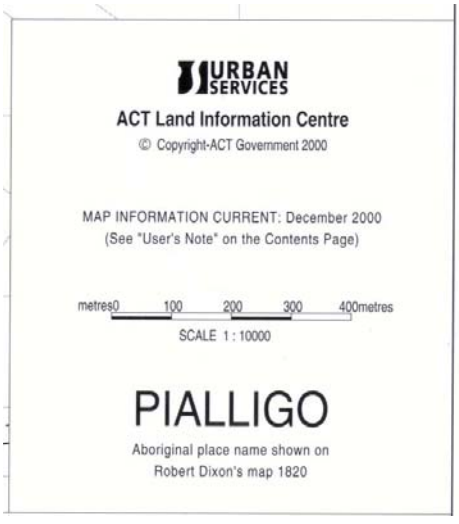
Common terms used

District The ACT is divided into 18 named districts e.g. Weston Creek, Canberra Central, North Canberra, South Canberra, and Gungahlin etc.

Division Each district in the developed areas is divided into named Divisions. Each suburb is in a different division. Open space areas adjacent to a suburb are also part of the division.

Section Each division is divided into numbered sections.

Block Each section is divided into numbered blocks. There is usually one residential lease for each block.


URBAN SERVICES
ACT Land Information Centre
© Copyright-ACT Government 2000
MAP INFORMATION CURRENT: December 2000
(See "User's Note" on the Contents Page)
metres0 100 200 300 400metres
SCALE 1 : 10000
PIALLIGO
Aboriginal place name shown on
Robert Dixon's map 1820

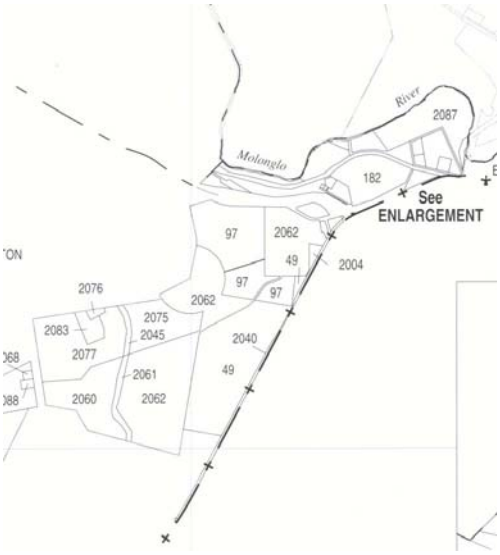
Because the book is loose leaf, each map has a title block with information relative to that map. The scales of the maps vary according to the density of the development.
Parts of the inner city areas are displayed at a scale of 1 to 2500; in suburban areas the scale is usually 1:5500, 1:6500 or 1:7500 while in the less developed areas a scale of 1:10,000 is used.
It is important to recognise that no map is ever up to date. On the PALM maps, the title block includes the date at which the information was current.

A great deal of information is shown in a small area.
The block numbers are in black, while the street addresses are shown in red.

In the commercial areas, building names are included.

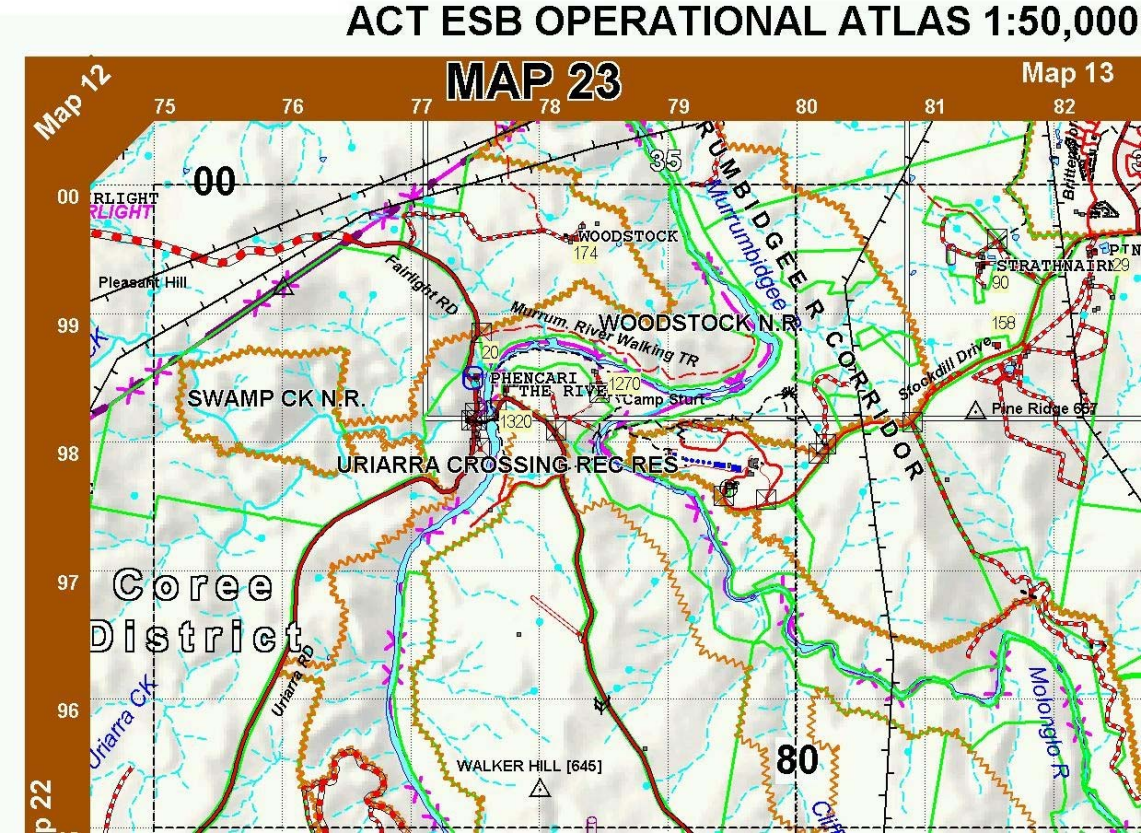
As these are likely to change over time, it is important to check the street address as well.

In the outer areas, only block numbers are provided.
These are not the same as rural addresses.



ACT Emergency Service Bureau Operational Atlas

It has long been recognised that every vehicle attending to an incident should have on board maps to assist in responding to incidents and to provide support in the initial phase of an incident. Issues with supply of folded topographic maps meant that we had to develop a more effective product. An A3 format, long-edge spiral bound was selected. The maps are arranged in street-directory fashion and are in two forms – topographic and orthophoto. The information shown in based on the best available data from both the ACT and NSW Governments.
The maps are at 1:50,000 scale and show a one-kilometre grid on the Map Grid Australia, allowing 6-figure grid references to be used.



Land Management Agency specific maps.

Forest Plantations are divided into Blocks, which cover around 10 square kilometers. Each of these is divided in to compartments, the basic area used for planning and planting. There are 10 to 30 compartments per block. Compartments are surrounded by access roads, but rarely have roads through them. This makes them the logical choice for wildfire containment. Foresters also describe local landmarks, such as "Toolbox Hill," the hill where someone once left their toolbox!

Forestry maps may not always represent what is reflected on the ground i.e. logging may be taking place so a compartment may be closed off or not accessible.

Environment ACT maps also develop their own maps such as land ownership and categorize land usage such as Nature Reserve or National Park etc. They will also provide site-specific information to assist with incident management such as species of significance, and sites of interest.

Rural Addressing – ACT's Rural Addresses using the Corio Model

The Australian Standard for Rural Addressing has been adopted outside the built up areas of the ACT. The old system was Roadside Mail Boxes (RMB's), which were a sequential number given by the local post office to rural addresses. On the ground the numbering appeared random.

The Corio Model replaces the RMB system, and allows you to figure out the location, on the ground of any address. RMB's are still being used in NSW.

The Corio system involves rural properties being allocated a number based on the distance the property is from the start of a road. Odd numbers are on the left, and even numbers are on the right. (This and the direction in which the numbers increase give you a check if you are going the correct way)

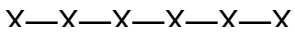
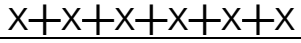
The number multiplied by 10 is the number of metres from the beginning of the road. Distances are measured along the roadway, not as the crow flies.

Navigation is possible. First are the odd numbers on the left? If so numbers will increase as you travel. Find a number – this tells you where you are along the road. Thus you know if you are traveling in the right direction and how far you must travel.

Monaro Highway numbers increase as you approach Canberra, whereas the numbers will increase as you travel away from Canberra on the Federal Highway. A property whose entrance gate is 1892m from the start of Wells Station Road and on the left would be given the address of 189 Wells Station Road. A property directly opposite would be 190 Wells Station Road.

Operational Maps

Under the Incident Control System that is utilised as a management structure in the ACT you may be required to provide an operational map, which may be hand drawn or sketched. It may be produced to show sector or division boundaries, or provide information of assets under threat, or damage that has occurred. This information is then used to assist in the management if the incident. It is essential to understand there are standardized map symbols that have been developed to ensure consistency across the states.

PREDICTED (fire edge)			
GOING (fire edge)			
CONTAINED (fire edge)			
PROPOSED (control line)			
COMPLETED (control line)			
PROPOSED (backburn)			
COMPLETED (backburn)			
BACKBURN BURNING IN			
Fire Origin			
Fire Direction	F		
Wind Direction	W		
Spot Fire	*		
Burnt Area			
Aerial Ignition			
Divisional Command	DC	Staging Area (Where resources are available)	SA
Helipad		Airbase (Fixed wing and/or helicopter base)	AIR
Water Point Vehicle (Firefighting water supply)	WV	Water Point Helicopter (Helicopter water supply)	WH
Threatened Property	T		
Divisional Boundary		Use geographical names	
Sector Boundary	OOOOO	Use alphabetical names	

Activity 8

List the various types of maps that you might be required to navigate from and their uses.

_____
_____
_____
_____
_____

Activity 9

A crew responding to a call from (Roseview) at 8663 Monaro Highway advises that they are at 8827 (Bellview), which is on their right hand side. In which direction should they proceed?

_____
_____
_____

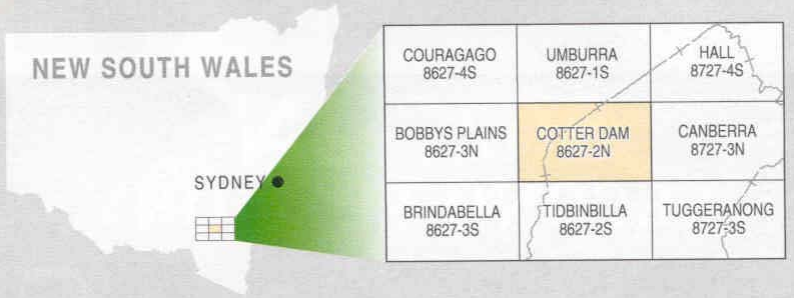
THE INFORMATION YOU NEED TO READ A MAP

All map users should be familiar with the information available in written and pictorial form around the edges of the map. This data identifies and explains the map, giving details not only for use in connection with the map itself, but also the date of the information and the sources from which it has been compiled. The type of information and the layout may differ slightly from one map to another. Listed below are the items that are normally part of the standard layout:

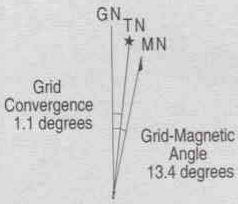
Marginal Information

A	Map title	Usually shown in the top centre of the map. It may be the name of an important town or an area and indicates roughly the coverage of the map.
B	Type of map	Usually located on the top left beneath the representative fraction. It describes the type of map, e.g. topographic, geological.
C	Map edition and sheet number	Usually located at the top right of the map and is sometimes reproduced at the bottom right.
D	Grid reference block	Usually located at the bottom left of the map, it describes how to calculate a six-figure grid reference.
E	North points diagram	Usually located on the bottom margin and shows, for a given year, the direction of true, magnetic, and grid north.
F	Conventional signs block	Usually a series of blocks located at the bottom of the map, which gives a legend of the conventional signs, used, together with their meanings.
G	Control and production block	Usually located at the bottom of the map, above the grid reference block and gives production details.
H	Index to adjoining sheets	Located at the bottom left of the map. It gives the title of adjoining maps.
I	Representative fraction	A method of indicating the scale of the map. Located at the top left of the map and also at the bottom above the linear scale.
J	Linear scale	Located at the bottom centre of the map.
K	Contour interval	The contour interval (vertical distance between contour lines) is shown beneath the linear scale, usually at the bottom of the map.
L	Magnetic variation	Usually at the bottom right-hand side of the map or under the north point diagram.

LOCATION AND ADJOINING MAPS



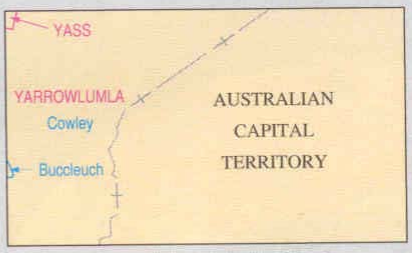
NORTH



True North, Grid North and Magnetic North are shown diagrammatically for the centre of the map.

Magnetic North value is correct for 2003 and moves easterly by less than 0.01 degree per annum.

KEY TO COUNTIES AND LOCAL GOVERNMENT AREAS



This diagram represents the extent of the title map.

KEY
SHIRE — local government area
County — county
_____ common boundaries

GRID REFERENCES

UNIVERSAL GRID REFERENCE

GRID ZONE DESIGNATION: 55H

100 000 METRE SQUARE IDENTIFICATION

FA

IGNORE the SMALLER figures of any grid number, these are for finding the full coordinates. USE only the LARGER figures of the grid number, for example: 325 000

TO GIVE A STANDARD REFERENCE TO THE NEAREST 100 METRES

SAMPLE POINT: Coree △ 1421

1. Read the letters identifying 100 000 metre square in which the point lies.
2. Locate the first VERTICAL grid line LEFT of the point and read the LARGE figures labelling the line in either the top or bottom margin;
3. Estimate tenths from the grid line to the point.
4. Locate the first HORIZONTAL grid line BELOW the point and read the LARGE figures labelling the line in either the left or right margin;
5. Estimate tenths from the grid line to the point.

FA 64 6 91 4

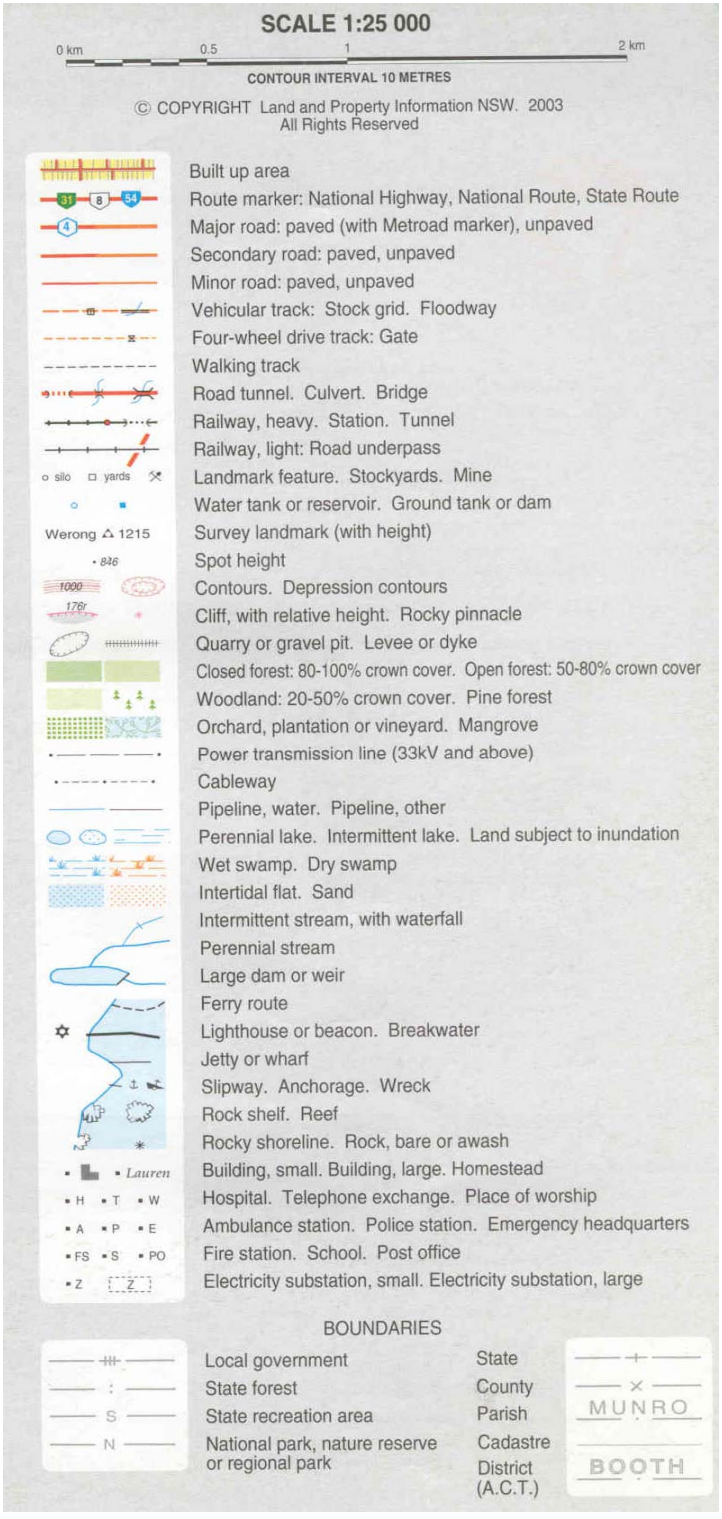
SAMPLE REFERENCE: FA646914

The 100 000 Metre Square Identification repeats every 18°. If reporting beyond 18° in any direction, prefix the reference with the Grid Zone Designation, for example: 55HFA646914

Before giving a grid reference civilian users should state the number and name of this map, for example: 8627-2N Cotter Dam 646914

Conventional Signs

The mapmaker tries to show the objects on the ground in the clearest possible way. The objects are shown by simple symbols, larger than scale, to enable them to be recognised.



Activity 10

Using the map provided, and from information provided by your Trainer, identify four or five map symbols from the map legend.

_____
_____
_____
_____
_____

Summary

The ability to read maps comes into almost all fields of SES and RFS operations – from a simple task of driving to the store for stationery supplies, to attending an emergency. Being able to read a variety of maps will ensure you arrive at your location in the shortest time possible.

SECTION TWO

READING TOPOGRAPHIC MAPS

Element	Performance Criteria
1. Determine current location, destination and resources	1.3 Cartographic information and navigation techniques are applied to plot positions on a map and determine current location and destination within accepted tolerances.

SESSION 2 – GRID REFERENCES

Learning Outcomes for this session:

- Explain how to determine locations on a topographic map
- Locate features using four figure grid references
- Locate landmarks using six figure grid references
- Use a Romer Scale

The Grid System

Topographic maps are the main map we use in the rural area as they show topography and landforms. Maps are provided with a system of horizontal and vertical lines called grid lines. The ground distance represented between the grid lines that form the squares is usually quoted in the marginal information of the map. Grid lines run vertically and horizontally. They are numbered at each end, and every tenth line is in heavier print. On some maps grid lines are also numbered at various places along their length.

Maps are printed so that north is at the top of the sheet.

To assist the user when giving grid references, grid lines are further defined as follows:

Eastings	The vertical grid lines, which run from bottom to top (or south to north), and divide the map from west to east, are known as Eastings. Their value increases towards the east.
Northings	The horizontal grid lines, which run from left to right (or west to east), and divide the map from south to north, are known as Northings. Their value increases towards the north.

The squares that are formed where Eastings and Northings cross are known as grid squares. On a 1:100,000 map they represent an area of 100 hectares or 1 square km. The distance along one side of a grid square should be equal to the primary division on the linear bar. On a 1:100,000 topographic series map, the ground distance represented between the grid lines is 1,000 metres or I km.

Grid References

There are four methods used, being four, six, eight and thirteen-figure grid references, to indicate positions on a grided map. The method used depends on the degree of accuracy required by the user and, to a large extent, the scale of the map being used. The basic principle for each method is the same and is explained below.

The accepted grid reference is a six-figure grid reference; this will indicate a position on a grided map. This will provide a degree of accuracy, which is required by the user

When giving grid references remember:

1. **Always deal with eastings first, then northings.**

   To help you remember this, use the following line:

   You have to crawl along the ground before you can climb a tree.

2. When working in the field near map borders, always include the map sheet number or the map title when transmitting grid references, to avoid confusing the number with a similar grid reference on another map.

3. Grid references should always commence with the letters **GR** to show that they are, in fact, grid references and nothing else.

4. Also note that grid numbers, on reaching 99, recommence the numbering sequence starting at 01.

Four Figure Grid Reference

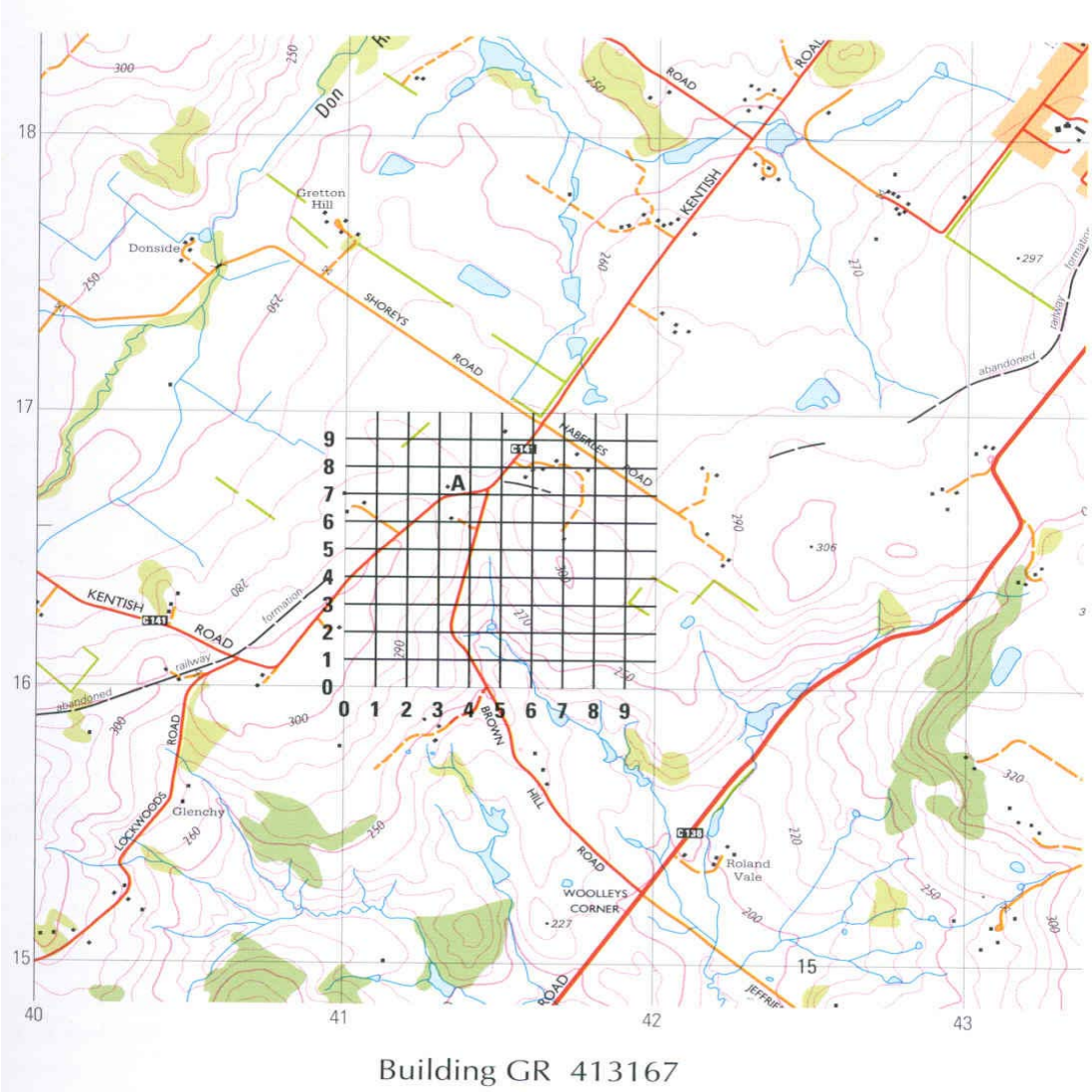
This method indicates the position of one grid-square only and is therefore useful when identifying major features and localities. To indicate a particular grid square:

1. Select the Easting that forms the left, or west boundary of the square.
2. Select the Northing that forms the bottom, or south boundary of the square.
3. The two figures for the Easting and the two figures for the Northing combined give the four-figure reference required.

Six Figure Grid Reference

This method is much more precise than the four-figure method and is used to indicate the position of an object within a grid square. A six-figure grid reference is given to indicate the boundaries of a fire, the location of a roadblock or a helipad. To do this, imagine each grid square is divided into 100 smaller squares, each square being 100 metres by 100 metres. You then estimate or calculate which small square the particular object is in.

The diagram below shows a grid square divided into 100 smaller squares to help explain the procedure. The numbering of the lines forming the small squares indicates the number of tenths of a unit there are east of Easting 41 or north of Northing 16. **House A** is in the small square 413 east and 167 north. In other words the Easting is 413 and the Northing is 167. The six-figure grid reference to House A is GR 413167.



Building GR 413167

"Image supplied by TASMAP"

Eight Figure Grid Reference

This method has limited practical use and is not often used. It is only suitable on maps with a scale of 1:50,000 or larger. The 100 metre squares used for determining six figure grid references are each broken down into 10 metres by 10 metre squares to determine an even more accurate location.

The Eastings reading now comprises the first four figures, while the Northing reading comprises the last four figures.

Activity 11

What are the grid lines called and in what order are they read?

_____

Activity 12

From information provided by your trainer, identify:

1. A landmark at a particular six figure grid reference _____
2. Grid references at given locations (6-figure)

a) _____

b) _____

Map Grids

Another way of describing a grid reference is to use metres instead of degrees minutes and seconds. The system uses the distance from a zero point and measures east and north of that point.

Maps issued by the State, Territory and Commonwealth Government since the mid 1990's use a version of this system, which is the Map Grid of Australia (MGA94).

These maps are easier to read, because:

- The grid lines are straight and not curves;
- The grid lines are based on metres, not the less familiar degrees, minutes and seconds used for latitudes and longitudes.

Metric maps issued before the mid 1990's may be based on the Australian Map Grid (AMG66, AMG88), whereas the more recent ones have been produced to the Map Grid of Australia (MGA94).

Places with the same grid reference may be up to 200 metres apart. Official maps and other good quality maps show the standard in the title block and scale diagram as part of the marginal information.

The MGA94 is one grid coordinate system based on the Universal Transverse Mercator projection and the Geocentric Datum of Australia (GDA) 1994. The unit of measure is the metre.

The Australian Geodetic Datum (AGD66, AGD88) was established before satellite techniques were available and was based on a model of the Earth that best suited the Australian region at the time. GDA94 is based on an international model which "best fits" the shape of the whole earth. Coordinates on the earth's surface change approximately 200 metres in a north-easterly direction with the new datum (GDA94). The exact distance and direction of the change will vary slightly from area to area.

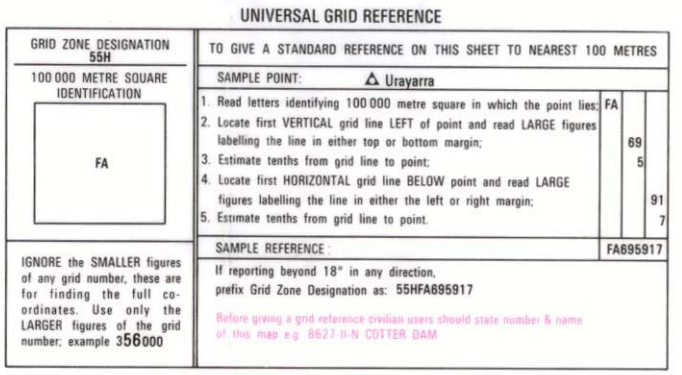
The MGA94 is based on an international standard, so it is suitable for satellite navigation instruments, such as GPS. The majority of new 1:25,000 maps and the 1:100,00 Bushfire Council map are in MGA94 and this is becoming the standard in the field.

When reporting a grid reference based on the old grid system (AMG) – add Alpha at the end of the coordinates. For a grid based on the new system (MGA) add Mike.

A: Ancient e.g. GR 982415 ALPHA

M: Modern e.g. GR 982415 MIKE

On the bottom of topographic map the grid referencing system is explained.
This provides the Grid Zone designation, an identifier for the map within the grid zone and a reminder of how a co-ordinate reference should be reported.


UNIVERSAL GRID REFERENCE

GRID ZONE DESIGNATION 55H

100 000 METRE SQUARE IDENTIFICATION

FA

IGNORE the SMALLER figures of any grid number, these are for finding the full co-ordinates. Use only the LARGER figures of the grid number; example 356000

TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 100 METRES

SAMPLE POINT: Urayarra

1. Read letters identifying 100 000 metre square in which the point lies: FA
2. Locate first VERTICAL grid line LEFT of point and read LARGE figures labelling the line in either top or bottom margin; 69
3. Estimate tenths from grid line to point; 5
4. Locate first HORIZONTAL grid line BELOW point and read LARGE figures labelling the line in either the left or right margin; 91
5. Estimate tenths from grid line to point. 7

SAMPLE REFERENCE : FA695917

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 55HFA695917

Before giving a grid reference civilian users should state number & name of this map e.g. 8627-II-N COTTER DAM

Thirteen Figure Grid Reference

While not all Units/Brigades will be required to use thirteen figure grid references, the following information would be an advantage to know.

The thirteen figure grid reference is an extension of the six figure Australian Map Grid (AMG) grid referencing system (i.e. Eastings and Northings are used to identify a feature on a map.)

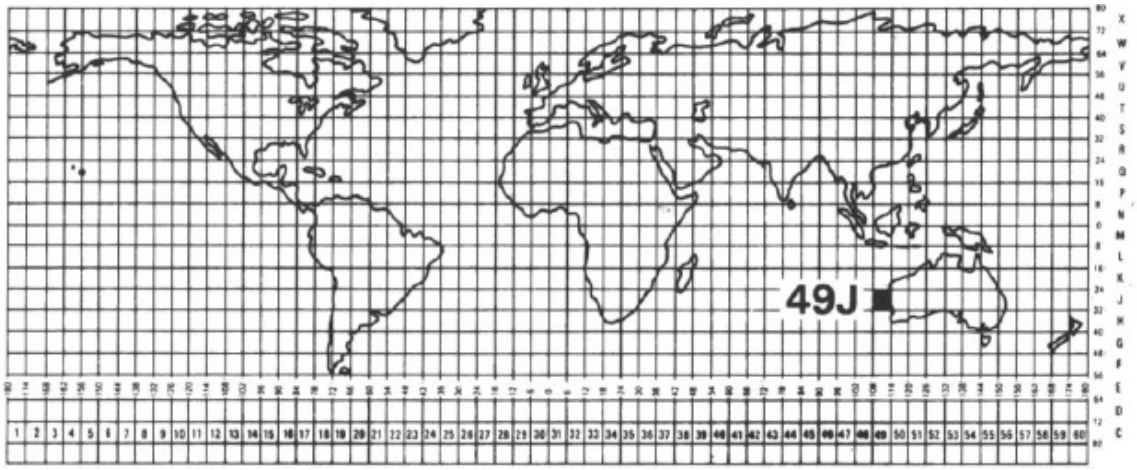
All AMG maps will have full values for Eastings and Northings located at the corners of the map. To fully understand how the thirteen-figure grid reference is derived, we shall first look at the Universal Grid Block system on the next page.

Calculating the thirteen figure grid reference

The calculation of the thirteen-figure grid reference uses the world map numbering sequence in addition to the six-figure reference. Once the map number is determined, identify the grid square that the feature is in and then estimate (or calculate) the tenths. The grid reference figure has Eastings first, followed by the Northings

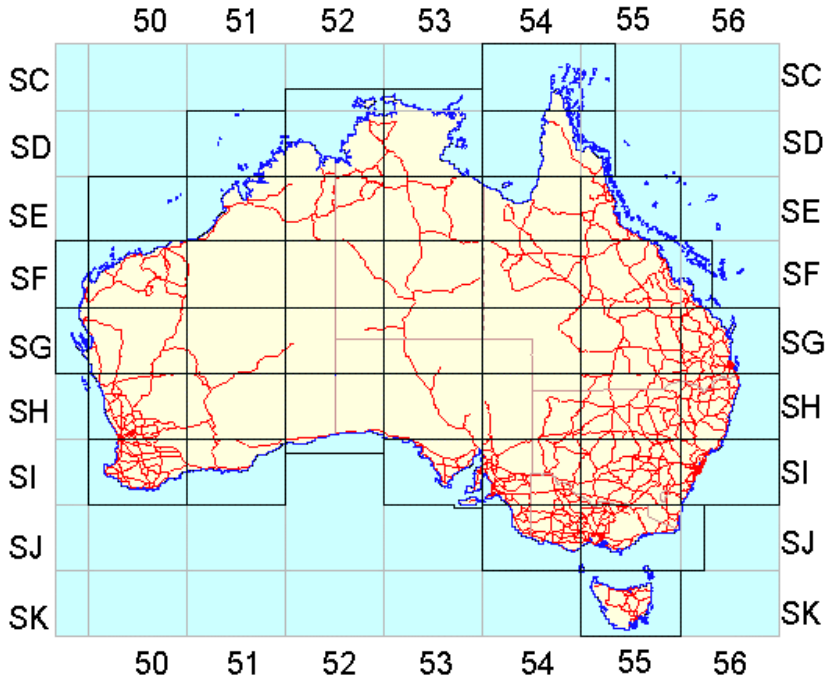
The Universal Grid Reference System

The Universal Grid Reference System is explained on the bottom of most maps, and indicates where a particular map fits into the world's series of maps.



Universal Grid Reference System

Reading from left to right, the map indicated in the diagram above is the 49th map of 60 across the world sector of maps, numbered from the International Dateline and 'J' sector, reading upwards, hence 49J.

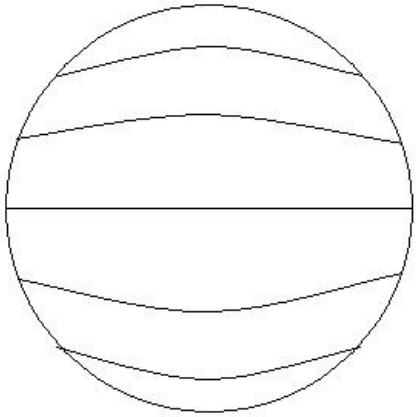


The map covering Canberra is numbered **55 SI** (the S refers to the southern hemisphere). The Grid zones are then further sub divided to provide more detail.

Latitudes and Longitudes

Longitude is used together with latitude to form a grid on which it is possible to locate any place on the earth.

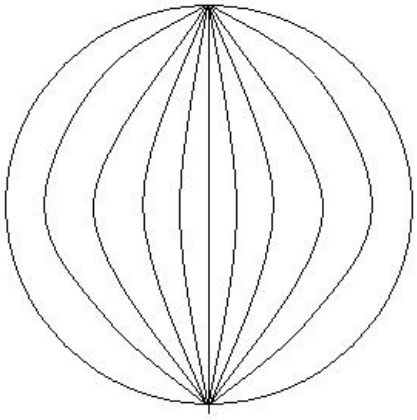
Lines of Latitude (parallels) run from east to west. They show how far a place is away from the equator. The equator's latitude is 0° and the poles are 90° south and north. One degree of latitude equals about 110 kilometres.



Canberra is located at a latitude of 35º S (south of the equator)

Sydney is located at a latitude of 33º S

Melbourne is located at a latitude of 37º S



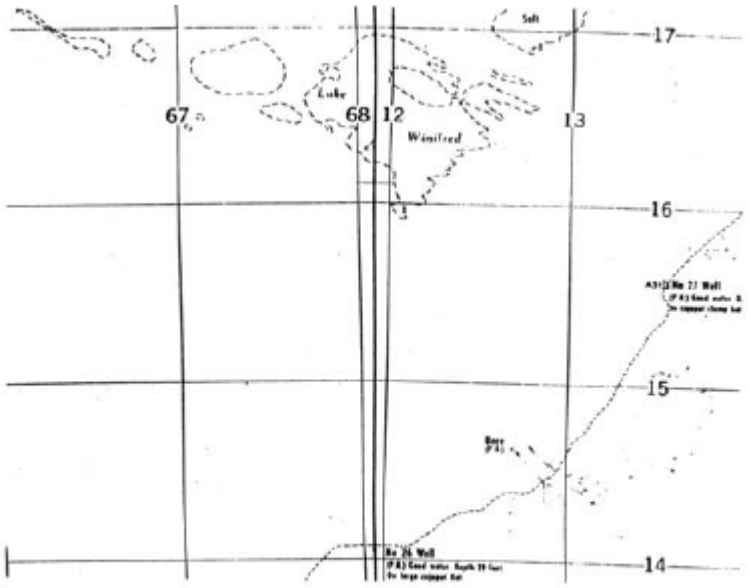
Lines of longitude (meridians) run from the north pole to the south pole. There are 360 equally spaced meridians, and at the equator, they are approximately 110 km apart. They become closer as we move away from the equator, and meet at the North and South poles.
Canberra is located at a longitude of 149º 08' East (of the Greenwich meridian). The distance between lines of longitude at Canberra's latitude is a little less than 91 km. (90.85 km.)

Sydney is located at a longitude of 151º S

Melbourne is located at a longitude of 144ºS

Grid Zone Junctions

In some instances a map can contain more than one grid. This occurs when two grid zones within the universal grid reference system join on the one map. Larger scale maps rarely see this occurrence, however on smaller scale maps junctions are more likely due to greater area of land covered. It is recommended when transmitting co-ordinates that the grid zone junction and sheet name and edition number are mentioned to alleviate any confusion during an incident.



A Grid Zone Junction

Romer Scales

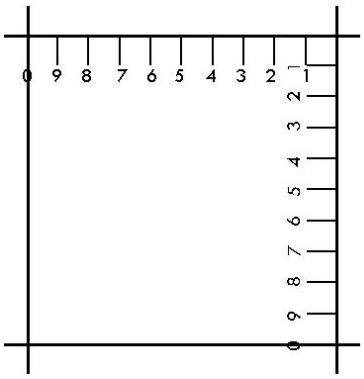
A romer scale is a simple device used for accurately measuring the position of a point within a grid square instead of estimating the tenths as described in the previous paragraphs.

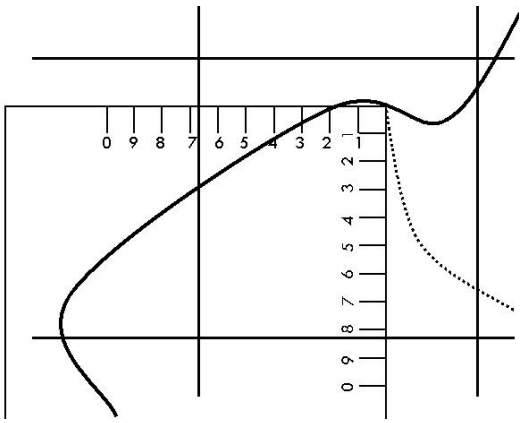
To use a romer:

1. Place the corner of the square against the required point on the map with the edges parallel to the grid lines.

2. The distance east and north within the grid square can then be read off against the west and south grid lines of the square.

The 10 division scale on the Romer fits neatly between the grid lines on common scale maps, such as 1: 50,000 or 1:100,000.





If the intersection is in grid square 6436, the Romer can be used to give a more precise location: 647368

A different romer scale is required for each scale of map. Romer scales for a variety of scales are sometimes engraved on protractors and also on the compass plate of **some** Silva compasses.

If such a romer scale is not available, one can be easily made from a piece of paper, overhead transparency film or cardboard, marking off the appropriate subdivision of a grid square from the secondary division of the linear scale on the appropriate map.

Activity 13

From information provided by your trainer, identify:

1. A landmark at a particular six-figure grid reference _____

2. Grid references at given locations (6-figure) using the romer scale.

_____

Activity 15

What information should be transmitted during an operation when you find a map contains a Grid Zone junction?

_____

_____

SESSION 3 – SCALE AND MEASURING DISTANCE

Learning Outcomes for this session:

- Explain the methods used to express map scale
- Measure distances on a map, both on straight lines and along roads

The scale of a map is the size relationship between the two points shown on a map and the same two points on the earth's surface.

Methods of Expressing Scale

There are two methods of expressing the scale of a map, Representative Fraction (RF) that is the preferred method and the Linear Scale

Representative Fraction (RF)

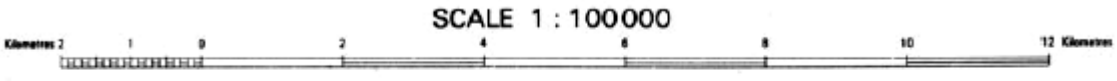
The numerator of the Representative Fraction that is always quoted as 1 represents the distance on the map the denominator, the distance. An RF of 1:100,000 therefore means that map distance will be 1:100,000 of that actual ground distance, or that a distance of 1 centimetre on the map will be 100,000 centimetres, or alternatively, 1000 metres or 1 kilometre on the ground.

An RF scale of 1:50,000 means 1 cm on the map represents 50,000 centimetres on the ground; or 500 metres, while an RF scale of 1:25,000 means 1 cm on the map represents 25,000 centimetres on the ground, or 250 metres.

Common scales for maps are 1:100,000, and 1:25,000. A map of 1:100,000 scale shows a larger area of land, while a map of 1:25,000 scale shows a smaller portion of land but in much greater detail. The 1:25,000 maps cater for the majority of incidents and provides enough detail for planning and operations.

Linear scale

On a linear scale bar the actual ground distance is quoted for its equivalent map distance and the zero appears a little way along so that only the portion to the left is finely divided. The correct way to use a scale bar is to take most of the reading from the major subdivisions and then to add to this the balance of the distance measured from the finer divisions.



Linear scale

Activity 15

List the two methods used to express scale on a map.

_____

_____

Measuring Distances on a Map

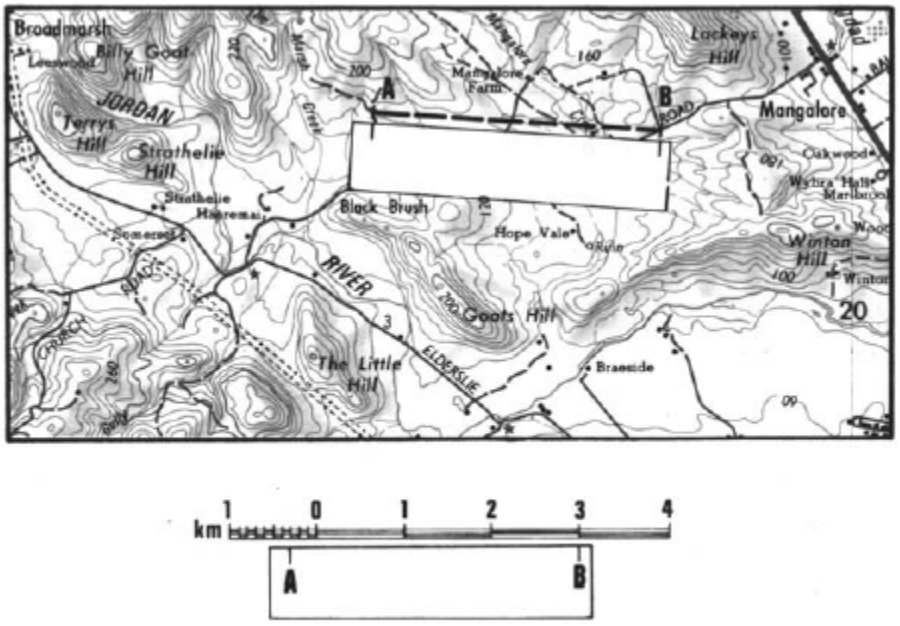
There are many ways of measuring distance on a map – by using dividers, a length of string, a ruler, etc. Two simple methods using a strip of paper are described below.

Measuring Straight Distance

Record the distance between the two points on a piece of paper, string, ruler or with dividers and then place one mark on a division line of the scale bar to the right of the zero so that the other mark falls on the smaller divisions to the left of zero.

The total ground distance between the measured points is then the distance shown on the scale bar to the right of zero plus that to the left. This figure is not truly represented on the ground and is only a guide as it does not take into account slope etc.

In the figure below, the distance is 3,000 metres + 300 metres, giving a total of 3300 metres or 3.3 km.



Measuring a straight distance

Activity 16

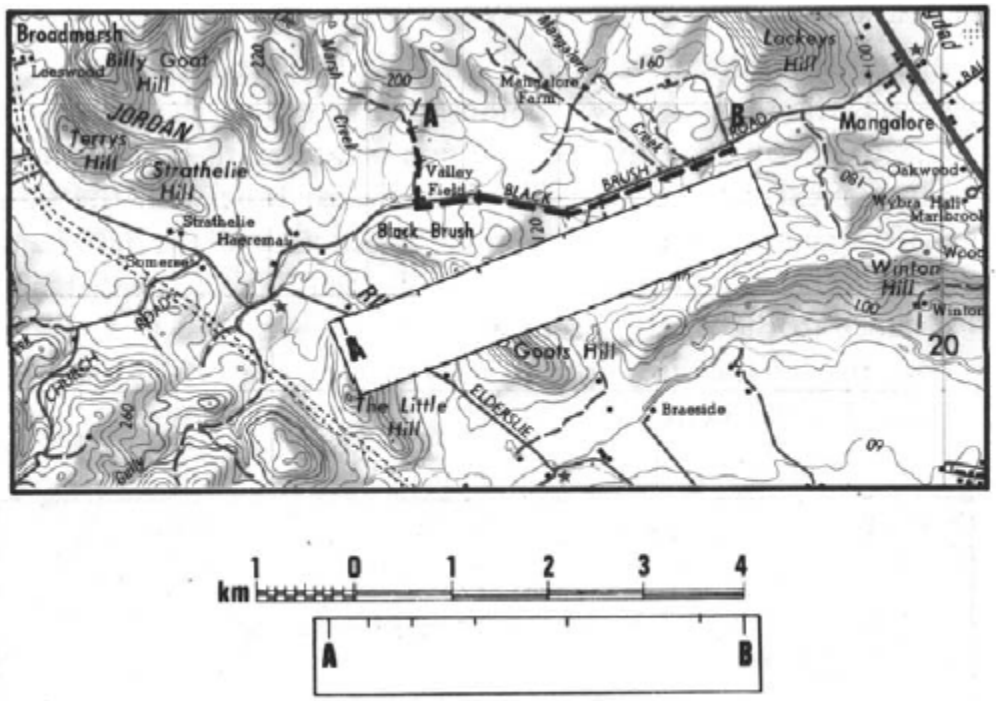
Select two landmarks on a map and measure the distance between them.

_____

_____

Measuring Distance along a Road

Consider the road as a number of straight, or nearly straight, sections and record these as a continuing measurement on the edge of a piece of paper. The total distance by road is then recorded as a straight line and can be read off against the scale bar.



Measuring distance along a road

SESSION 4 – SHAPE OF THE GROUND, GRADIENTS AND INTERVISIBILITY

Learning Outcomes for this session:

- State and describe the methods used to draw relief on a map
- Calculate the gradient of a hill
- Make a section for Line of Sight determination

Shape of the Ground (Relief)

Manufactured features, such as towns, roads and railways occur on the surface of the ground. Their details change quite rapidly. The shape of the ground (often referred to as relief) is permanent and determines the nature of the life lived on it, the type of things built on it, the position of towns and the direction and forms of communications.

The importance of being able to visualise, from the map, the shape of the ground is obvious. It shows what positions may be suitable for good observation, what ground is good for cross country movement, etc.

There are two distinct elements in the representation of relief. These are representation of:

- Height, and
- Shape.

Representation of height is a factual matter in which the variations will arise from the type and accuracy of the information is provided. On the other hand, representation of shape may be largely artistic and the methods will vary on different maps.

Methods of showing relief

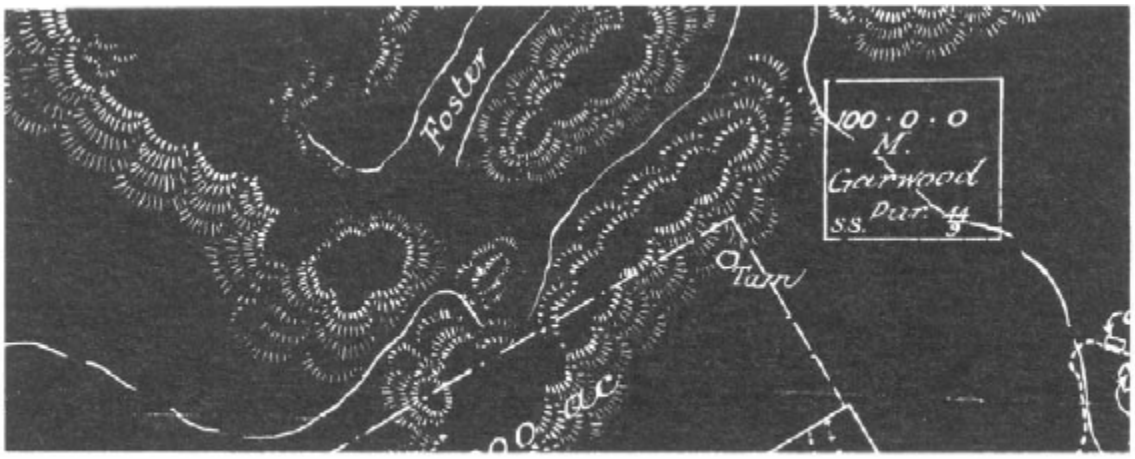
There are many ways of showing relief on a map, including:

- Hachures,
- Hill shading, and
- Contours.

Hachures:

This method may be used in sketch maps. Hachures show rising ground by a shading of fine lines down the line of the slope and are heaviest on the steepest slopes. They give a good impression of the shape of the ground but they have two great disadvantages:

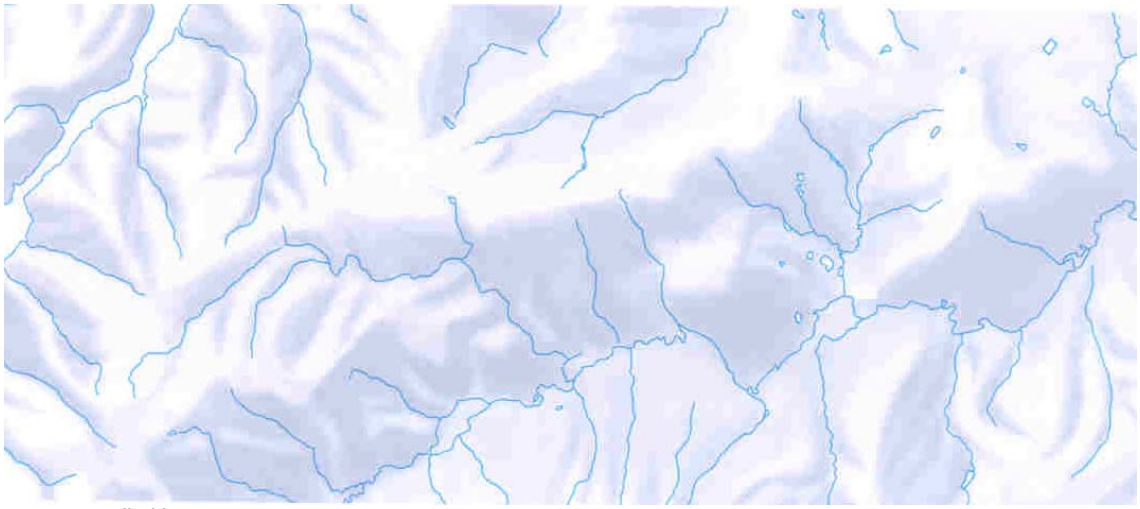
- They do not show exact information regarding height, only the illusion of height, and therefore heights and slopes cannot be measured.
- The hachure lines tend to obscure other detail on the map.



Hachures

Hill shading:

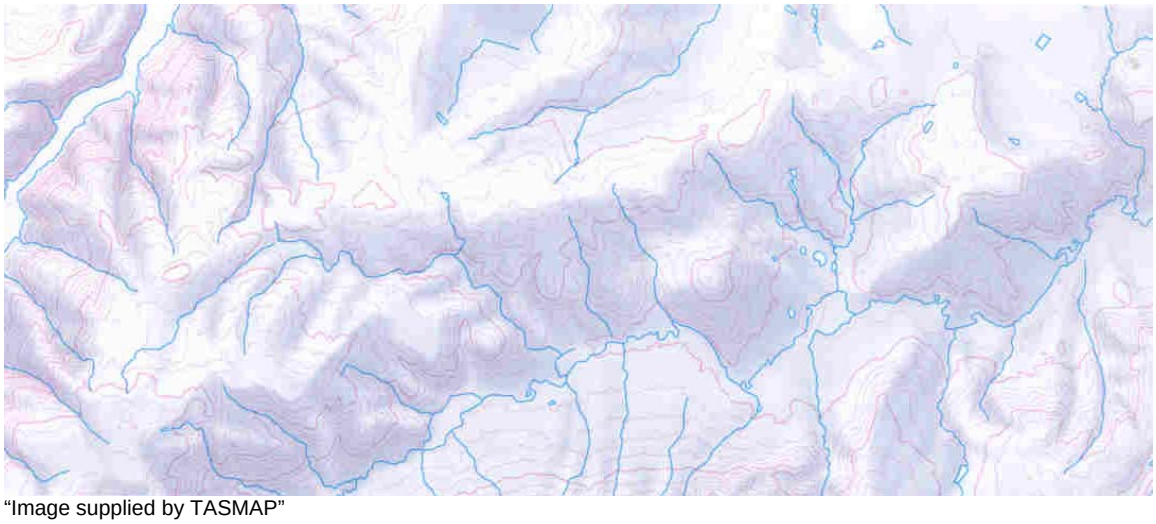
Hill shading shows by darkness of colour what hachures show by lines. The shading may be applied so that colours darken as the ground rises, or it may be applied as if the light was coming from one direction, so that one side of a hill is shown in a lighter shade than the other to give greater definition. Hill shading is sometimes used as well as contour lines.



"Image supplied by TASMAP"

Contours:

The most usual way of showing relief is by the use of contour lines. Contours not only give a representation of height but also indicate the shape of the ground. The idea of a contour is simple. It is an imaginary line drawn on a map, joining all places of equal height above a fixed datum (or reference) line (usually sea level).



"Image supplied by TASMAP"

Height of contours:

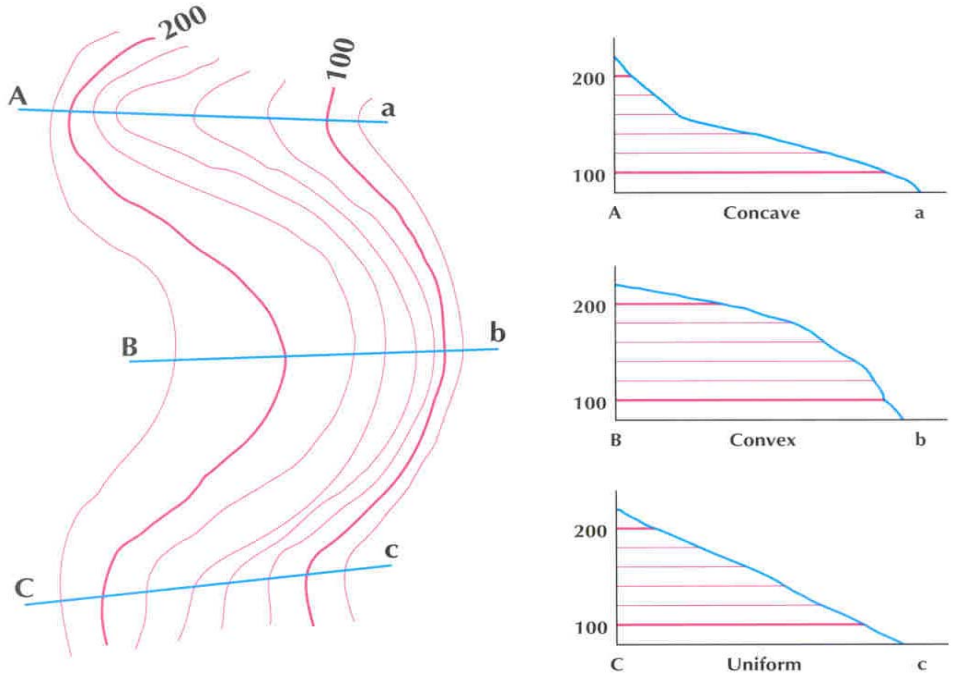
On the map, each contour is drawn at a specific height above a fixed datum. The vertical (height) difference between contours is called the contour interval and is shown in the marginal information on the map. It is important to realise that if the contour interval is 20 metres, for example, something smaller than 20 metres may not appear on the map.

Every fifth contour may be drawn heavier to aid measuring height. These are known as index contours. Some contours have the height shown at intervals along their length. On most maps these heights are printed so that they read correctly when facing uphill. This can be useful when determining the direction of high ground.

Contour patterns

Each topographic feature, such as a spur or a knoll, is represented by its own particular contour pattern. The diagram below shows some contour patterns.

- The most important points to remember about contour patterns are:
- Contour lines close together indicate steep slopes
- Contour lines far apart indicate gentle slopes
- Evenly spaced contour lines indicate uniform slopes
- When the contour lines curve away from the height of the slope, the slope is convex
- When the contour lines draw back up to the top of the slope, the slope is concave.



"Image supplied by TASMAP"

Representation of height

Fixing the height above sea level at selected points shows height without reference to shape. Three common methods are described below in order of accuracy.

Bench mark

- Usually a permanent mark cut into a stone, built into a wall or on the side of a triangulation pillar, the position and height is calculated from Trigonometrical stations.
- The height given is the height of the mark and not the level of the ground.
- It is represented as:

BM ·94

Trigonometrical (trig) stations

- Most accurate, these are usually shown on maps and are defined on the ground by a mark in a concrete block under a survey beacon.
- It is represented as:

Spot elevation

- Less accurate heights and are without a definite mark on the ground.
- Selected to indicate the height of the ground at points such as tops of hills.
- Accuracy will vary, but are as accurate as the contours.
- It is represented as:

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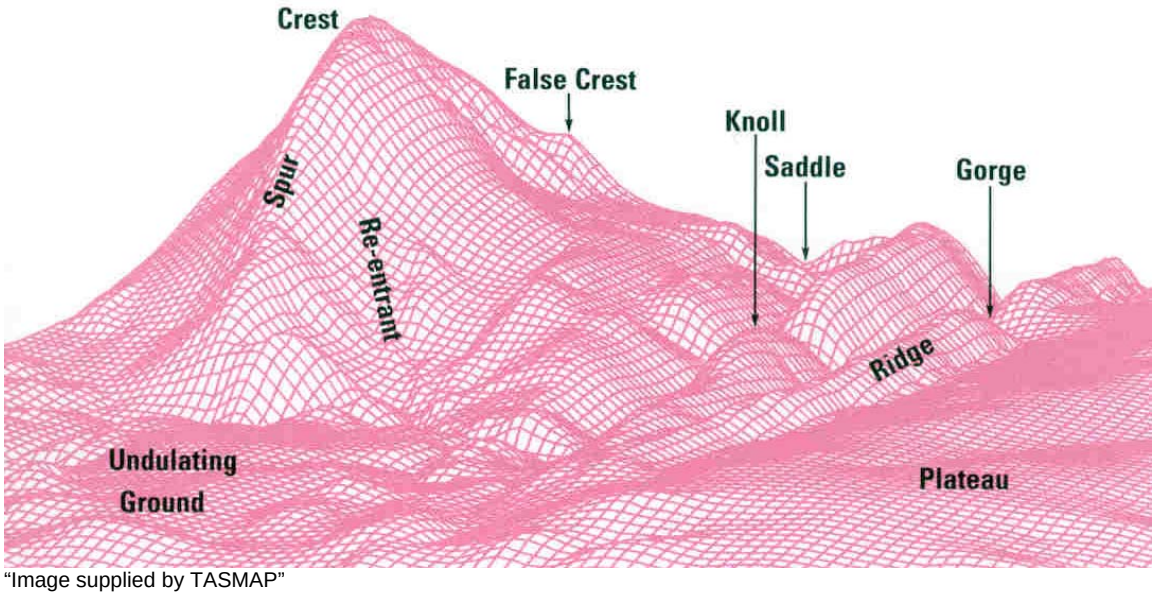
Physical features

Some common terms for the various physical features shown on a map are listed below and illustrated on the next page.

Basin	An area of reasonably level ground surrounded, or nearly surrounded, by hills; or an area drained by a river and its tributaries.
Crest	The highest part of a hill or mountain range. That line on a range of hills or mountains from which the ground slopes down in opposite directions.
Escarpment	The steep hillside formed by a sudden drop in the general ground level, usually from a plateau.
Gorge	A deep ravine usually with steep sides.
Knoll	A small knob-like hill.
Plateau	A tableland. An elevated region of considerable extent, generally fairly level.
Ravine	A long, deep, narrow valley worn by a stream.
Re-entrant	A valley or ravine, usually between two spurs, running inward towards the hill or mountaintop.
Ridge	The line along a hill or range of hills or mountains from which the water flows in opposite directions; sometimes the crest of a line of hills as it appears along the horizon.
Saddle	A depression between adjacent hills or mountain tops
Spur	A minor feature, generally in the form of a ridge, running out from a hill or mountain
Undulating ground	Ground, which rises and falls gently.



"Image supplied by TASMAP"

Activity 17

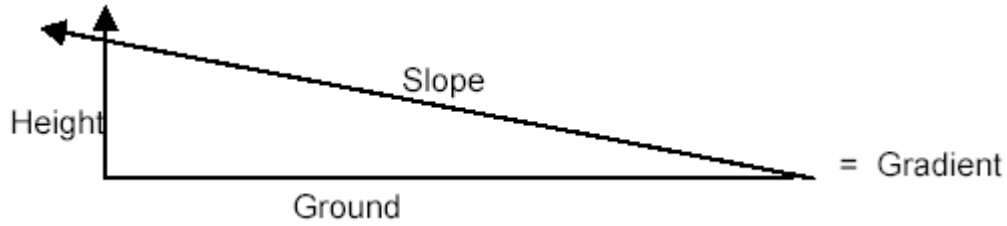
Your trainer will provide you with several grid references and ask you to:

a) Outline convex and concave slopes

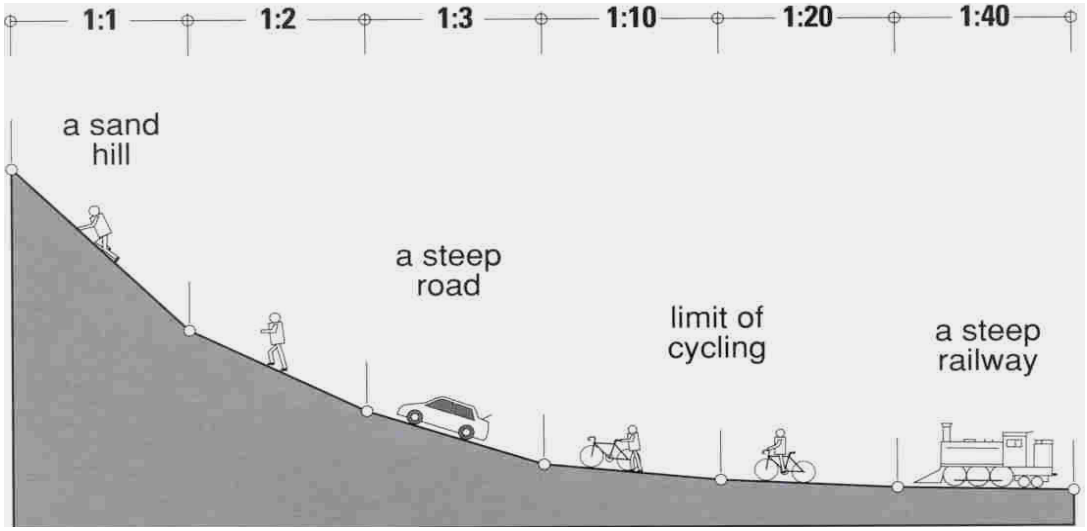
b) Outline land features, such as knolls, saddles and spurs.

Gradients

The slope of the ground may be expressed as the angle the ground makes with the horizontal, but more commonly it is referred to as a gradient, for example 1 in 10 or 1 in 20, which may be written as 1:10 or 1:20. A gradient of 1 in 10 means that in a distance of 10 units horizontally, the ground rises or falls 1 unit.



The eye exaggerates slopes to the extent that many people looking down a slope of 1:1 would say that it was vertical. Looking down a slope of 1:3 or 1:4 they would be convinced that it was at least 1:1. It is important, therefore, to be able to visualise the slope or gradient of the ground from a study of the map. The following diagram shows the effect of various gradients.



"Image supplied by TASMAP"

Activity 18

Determine the gradient of the diagram at the top of the page by measuring the vertical and horizontal distance. Can a vehicle drive up that slope?

_____

_____

Measuring gradients

Gradients can be measured accurately using instruments designed specifically for that purpose. Reasonably accurate results can also be achieved by using information from the map. When working on a valley floor and you see the hilltop or knoll, it usually appears to be a very direct route from the where you are. It is useful to work out the gradient as what looks like an easy walk becomes a very difficult and tiring expedition. By reading the contours and gradient an easier route may be found, the time you take may be longer, but the energy and ease in walking may be more efficient.

To calculate a gradient:

1. First measure the horizontal distance on the map between the two points to be traveled. For example, let's say it is 550 metres in distance. (Always express the distance in the same unit as the contour interval.)

2. Count the number of contour lines to be crossed en-route and multiply this number by the contour interval distance - e.g. 5 contour lines crossed x 10 metre contour interval. This means a climb of 50 metres in the 550 metres to be traveled.

3. To calculate the gradient, divide the contour interval into the distance to be traveled. To use our example, divide 50 metres into 550 metres. The ratio would be 1:11.

Maximum gradient for cross-country vehicle use

As a guide for successful cross-country vehicle use, the gradient of a road or track should not be less than 1:6 except for short distances and should never be less than 1:3, this will ensure safety from the vehicle potentially rolling. Other training courses are available with more in-depth information in regard to this subject.

Activity 19

Your trainer will provide you with grid references for two locations from which you will determine the gradients.

_____

_____

_____

Intervisibility (Line of Sight)

Instances may arise where it will be necessary to determine what area of ground can be primarily covered by line of sight from a given point or to determine the profile of the ground between two pints on a map. You may be in a vantage point to offer people advice on the ground whether, where they are planning to navigate to will be achievable.

Examples of this are:

- Planning and establishing radio communications (particularly VHF) from one point to another;

- Assessing the area of observation from a fire tower lookout.

In simple cases an inspection of the map may show clearly whether or not intervening higher ground exists between the points under consideration. Obvious obstructions other than intervening higher ground may be trees or buildings and these must be taken into account.

Where intervisibility is not certain by inspection, it is necessary to make a section of the line of sight as explained below. A section is a diagram to show the rise and fall of the ground along a line between two points.

Making a section

To make a full section between two points (A and B) on a contoured map, follow the steps below (refer to the following page):

1. Draw a line on the map between the two points. Find the highest and lowest contours cut by the line (see Diagram A).

2. Lay a straight edge of a piece of paper along the line AB and mark it at points A and B together with the points at which each contour cuts this line. Label each mark with its height, allowing extra 10 metres for the heights of trees where necessary. In addition mark creeks and crests (see Diagram B).

3. On a separate piece of paper draw a graph of sufficient equally spaced, parallel lines so that each line represents a contour or height value. Number these lines in sequence according to their contour value. Allow one value higher than the highest point and one value below the lowest point on the section line AB.

4. Draw perpendicular lines down from the marks made in Step 2 to its corresponding contour height.

5. Make a mark on each parallel line where it cuts the perpendicular, sent from the marked piece of paper, corresponding to its height on the line AB. Join these marks with a smoothly curved line, allowing for the general slope of the ground between contours at the bottom of valleys and the tops of hills.

   The slopes will be exaggerated, depending on the ratio of the map scale to the vertical height scale selected, but otherwise the section will give an accurate representation of the surface of the ground along the line AB.

This calculation does not take into consideration the height of trees or vegetation, rather it is only a representation of the height of the ground.

If only visibility of A to B is required, a hasty section showing hilltops only will suffice. It is constructed in the same manner as a full section, except that high points only are marked.

The use of squared graph paper makes the drawing of a section easier and quicker.

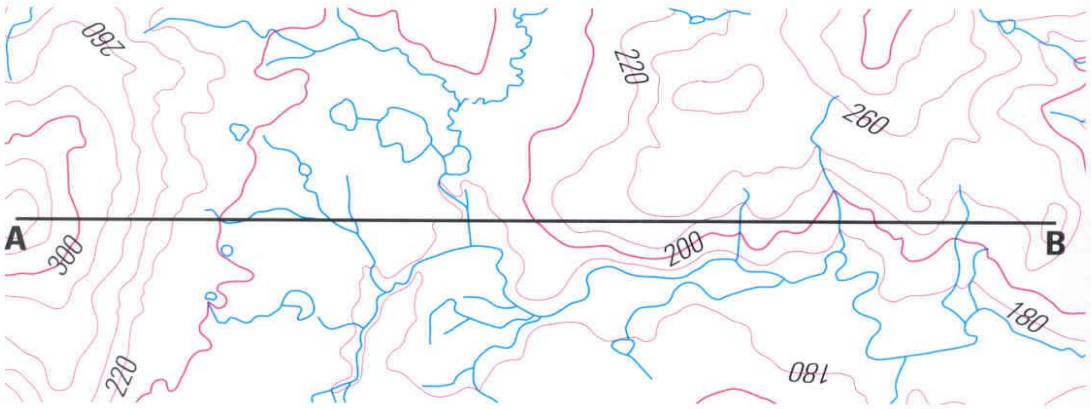


Fig. 15a

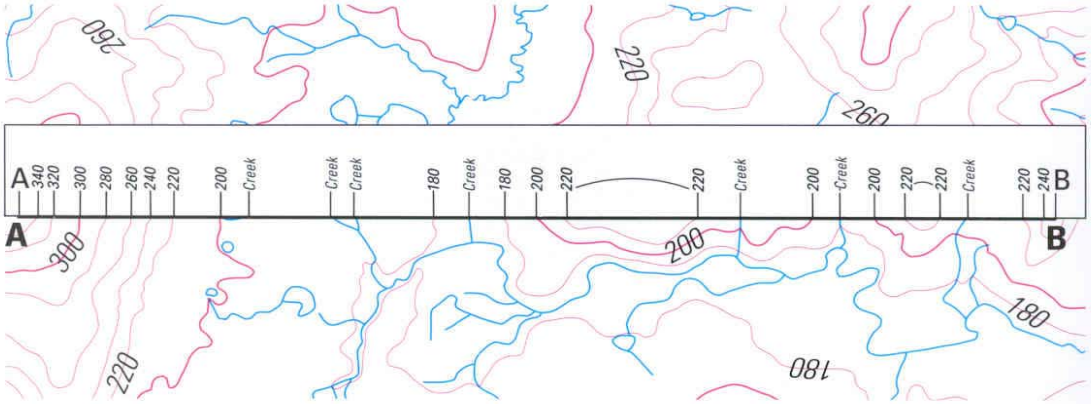
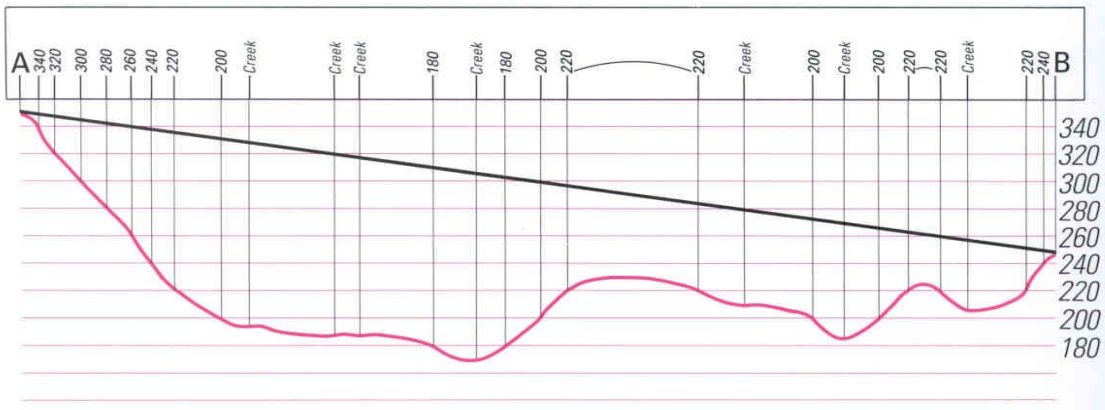


Fig. 15b



"Images supplied by TASMAP"

Activity 20

Your trainer will provide you with several grid references and ask you to:

a) Draw a section

or

b) Estimate the possibility of line of sight from the lay of the land.

SELF CHECK

	YES	NO
Did you understand the activity/activities you were asked to do?		
Did you have enough time to complete the activity/activities?		
Can you explain where you can use your map reading and navigation skill and when might it be needed?		
Can you name and describe the most commonly used map types for emergency service work?		
Can you explain the marginal information (including conventional signs) on a map?		
Can you interpret different methods of expressing scale on a map?		
Can you measure distance on a map?		
Can you calculate 4 and 6-figure grid references?		
Can you look at a map and determine the shape of the ground?		
Can you measure gradients and make sections?		
Can you explain the reason grid zone junctions occur?		

- If you have answered YES to all of the questions above, you are ready for the next topic.
- If you have answered NO to any question, ask your trainer for help.
- If you don't feel confident with an activity, you may want to go back and review it.

SECTION THREE

COMPASSES AND BEARINGS

Element	Performance Criteria
1. Determine current location, destination and resources	1.3 Cartographic information and navigation techniques are applied to plot positions on a map and determine current location and destination within accepted tolerances.

SESSION 5 – THE COMPASS, BEARINGS AND BACK BEARINGS

Learning Outcomes for this session:

- State the points of a Compass
- State the North Points
- Use a Protractor to plot a bearing on a map
- Use a Protractor to measure a bearing on a map
- Explain how to calculate a back bearing.

Introduction

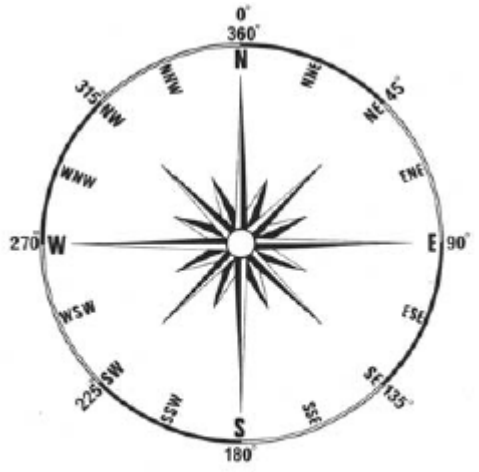
Grids, scales and contours provide a standard way of describing a location. Direction information can also be obtained from a map to provide a standard way of describing how to get from one point to another.

The compass, the sun and the stars have been standard tools for explorers and seafarers for thousands of years. The procedures that they developed are the basis of techniques as modern as satellite navigation.

Bearings taken in the field using a compass can be used to determine the direction of smoke sightings and to determine various locations of an accident etc. The fire towers use the bearing and distance system for a smoke sighting, a triangulation is given from the other towers if possible which will give a more precise location. These bearings are drawn onto maps using protractors to plot positions.

Direction

North, south, east and west are the four cardinal points (or key points) of the compass. There are, in all, thirty-two points of the compass but only sixteen are normally used in the map reading. The four cardinal points and twelve intermediate points are shown below.



Points of the compass

Degree System

The points of the compass give a rough indication of direction only. For greater accuracy, the circle is divided into 360 degrees with o (or360) being the north point. The four quadrants of the circle are each 90 degrees and therefore the east, south and west points are at 90, 180, and 270 degrees respectively.

Each degree is sub-divided into 60 minutes and each minute into 60 seconds. Degrees are marked thus °, minutes 'and seconds ".

When the compass is being used, the subdivisions of a degree are too small for practical use and readings to one half of a degree are generally sufficient, depending on the type of compass used. This example learning resource uses the degree system.

North Points

In map reading reference may be made to three *north point*s, shown in the diagram opposite. Each is explained in detail below.

north (TN)	➢ The earth spins on an axis, which passes through the north and south poles. The North Pole is geographical north, or true north. ➢ Lines drawn from the North Pole to the South Pole are true north south lines, or meridians. ➢ True north is therefore the direction from any point on the earth's surface to the North Pole.
Grid north (GN)	➢ Grid north is the direction of all the vertical lines on a topographic map. ➢ The grid lines on a map do not lie true north and south except possibly along one standard Easting. Elsewhere on the map they make an angle with the true north-south line. ➢ Since the grid lines are parallel, and since they are drawn on the map, it is very convenient to use them for drawing or measuring bearings. ➢ The direction of the Eastings grid lines is therefore known as grid north, and is used in preference to true north when reading a map. ➢ When working from a grided map, all bearings plotted from the map are referred to as grid bearings and not true bearings, even though they may only differ by a small amount. ➢ The difference between GN and TN is called the grid convergence and its value is shown in the north point's diagram.
Magnetic north (MN)	➢ To say that a compass points north is only relatively true because a compass needle does NOT point to the North Pole. ➢ It points to the magnetic pole, which differs from the North Pole. Its position varies slightly from year to year. ➢ The direction a compass needle points when freely suspended is known as magnetic north.

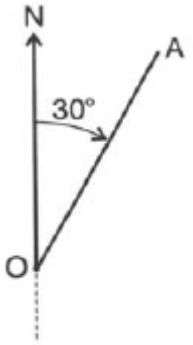
Bearings

The purpose of a bearing is to give an accurate indication of the direction of one point from another. A bearing is the angle, measured clockwise, that a line makes with a fixed zero line. Unless stated otherwise, the zero line is always taken to be north.

- If you are standing at point O and the bearing of A is 30°, it means that the line OA makes an angle of 30° with the north-south line.

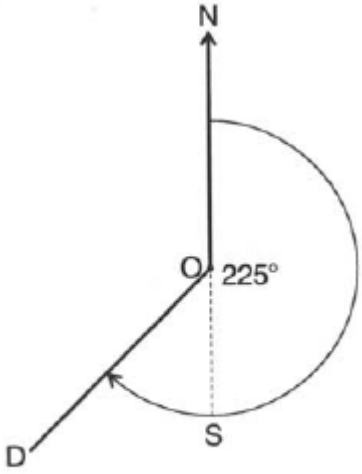
- The essential point to remember is that bearings are always measured clockwise from north, and therefore bearings of any direction to the east of the north-south line fall between 0° and 180°.

- Bearings of any direction to the west of the north-south line fall between 180° and 360°.



Bearings

The following diagram emphasis's how the angle of the bearing is always measured clockwise, thus bearing OD is 225°.



Bearings

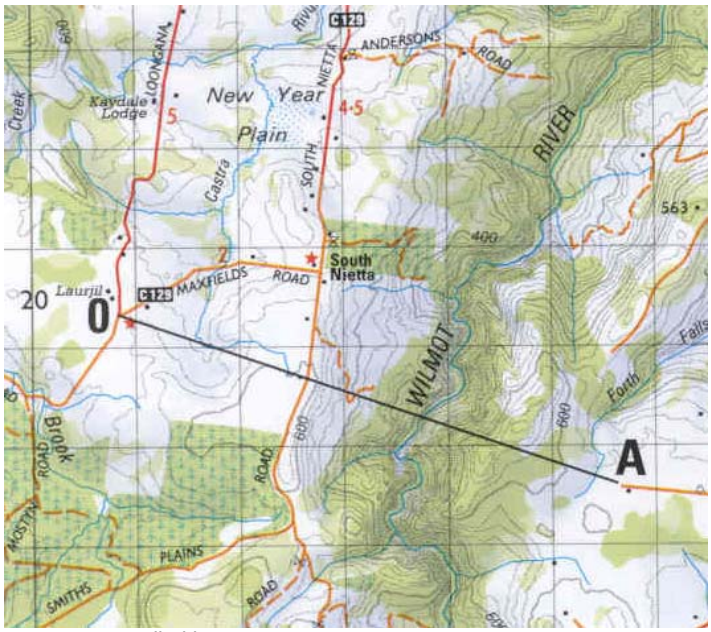
Protractors

To take a grid bearing on a map accurately, use a protractor. All bearings taken with a protractor are grid bearings. This is mainly used in incident rooms and to gain a more accurate account of the information being provided form the field.

There are many different types of protractors available and although they differ in design and shape, they are used in much the same way. Most protractors are made of a clear, solid plastic material or wood with a thin plastic veneer. They may be circular, semicircular or rectangular in shape. The outer edge of the protractor is graduated in degrees from 0 to 360, clockwise. Situated in a suitable position on the protractor is a north line and a centre point or hole. Protractors are very simple to use.

To take a grid bearing from the road junction at point O to the power line at point B, using the protractor to take a grid bearing on a map proceed as follows:

1. Using a straight edge and a fine pencil, join O and B as in the diagram below. (If the distance between the two points is small, it is advisable to extend the line through the object to which the bearing is to be taken, to ensure the line is visible when the protractor is positioned on the map and that it crosses an Easting.)

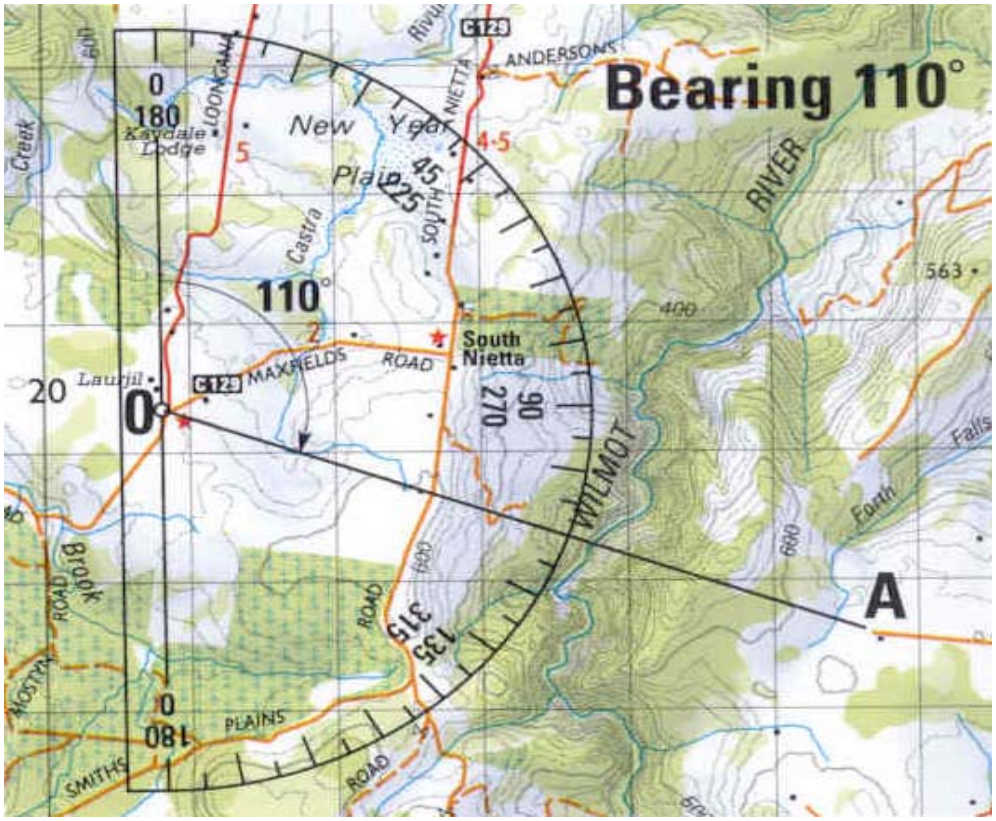


"Image supplied by TASMAP"

2. Place the protractor on the map and position it so that the centre point or hole is directly over the intersection of the line and the Easting, with the north line of the protractor aligned with the Easting. (Refer to the diagram on the following page).

3. You can then read off the bearing at the graduated edge of the protractor where the pencil line meets it.

4. Take care in orienting and reading graduations on semicircular or rectangular protractors. Both these types of protractors contain two sets of figures, one being the back bearing of the other.



"Image supplied by TASMAP"

To plot a bearing on a map, proceed as follows:

1. Place the protractor on the map and position it so that the centre point or hole is directly over point O (the location on the map from which the bearing is to be plotted) and the north line is parallel to an Easting.

2. On the graduated edge of the protractor find the bearing you have been given to plot. Mark the map with a pencil at that bearing.

3. Remove the protractor and draw a thin line through point O and the pencil mark. This line is the required grid bearing.

Activity 21

From grid references provided by your trainer, practice using a protractor to measure a bearing.

_____

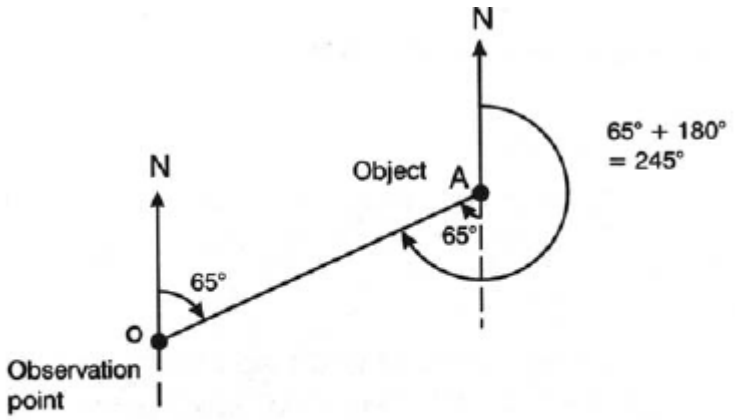
Activity 22

From grid references provided by your trainer, practice using a protractor to plot a bearing.

_____

Back Bearings

A back bearing gives the direction from the object back to the point of observation. It is clear from the example that the difference between the bearing and the back bearing is 180°. Therefore, given the bearing, to find the back bearings add 180°; or if the bearing is more than 180° subtract 180°.



Back bearings

So if the bearing to the object is greater than 180°, subtract 180°,to get the back bearing. If the bearing to the object is less than 180°,add 180°, to obtain the back bearing.

Activity 23

You have been proceeding on a magnetic bearing of 215 degrees and need to return to your original location. What bearing will you now walk on?

_____

Activity 24

You have been walking on a magnetic bearing of 25 degrees and need to return to your original location. What bearing will you now walk on?

_____

SESSION 6 – MAGNETIC VARIATION

Learning Outcomes for this session:

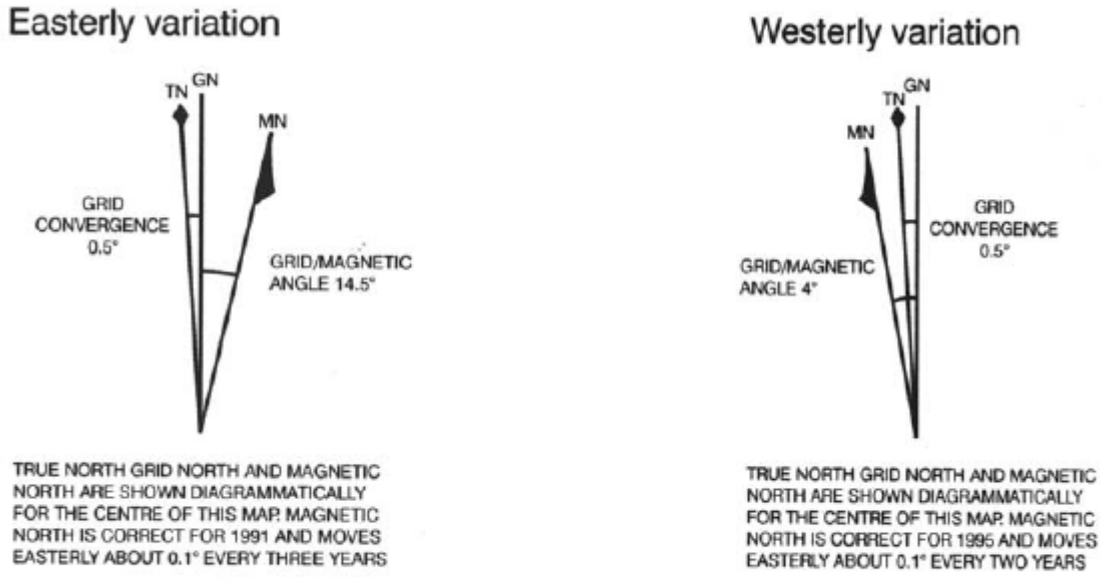
- Demonstrate the calculation of Magnetic variation
- Explain converting grid bearings to magnetic bearings
- Demonstrate converting magnetic bearings to grid bearings

Magnetic Variation and Grid Magnetic Angle

The angle between the magnetic north line and the true north line at any place is the magnetic variation (or magnetic declination) for that particular place. As GN is used in preference to TN it is more useful to know the size of the angle between GN and MN. This is called the grid/magnetic angle (GMA) and its value is shown in the north points diagram below.

The position of the magnetic pole is not fixed; it moves slightly from year to year. Consequently, the direction of magnetic north and therefore the magnetic variation also changes by a small amount each year. Though this change is not constant it can be forecast with sufficient accuracy over a number of years and details of the annual change are given in the marginal information.

Note carefully whether the annual change has to be added or subtracted. If the annual change is the same direction as the magnetic variation it must be added; if they are opposite directions the annual change must be subtracted.

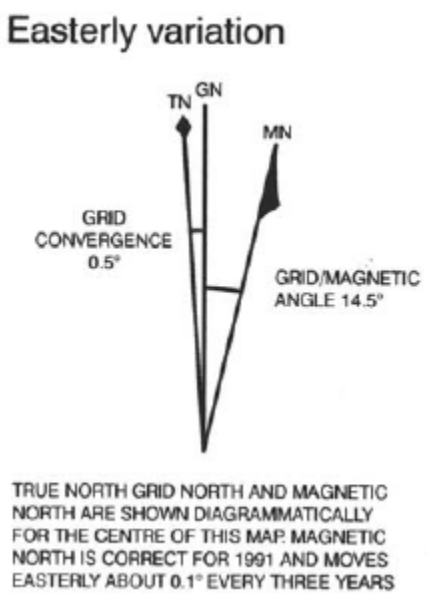

Easterly variation
TN
GN
MN
GRID CONVERGENCE 0.5°
GRID/MAGNETIC ANGLE 14.5°
TRUE NORTH GRID NORTH AND MAGNETIC NORTH ARE SHOWN DIAGRAMMATICALLY FOR THE CENTRE OF THIS MAP. MAGNETIC NORTH IS CORRECT FOR 1991 AND MOVES EASTERLY ABOUT 0.1° EVERY THREE YEARS
Westerly variation
TN
GN
MN
GRID CONVERGENCE 0.5°
GRID/MAGNETIC ANGLE 4°
TRUE NORTH GRID NORTH AND MAGNETIC NORTH ARE SHOWN DIAGRAMMATICALLY FOR THE CENTRE OF THIS MAP. MAGNETIC NORTH IS CORRECT FOR 1995 AND MOVES EASTERLY ABOUT 0.1° EVERY TWO YEARS

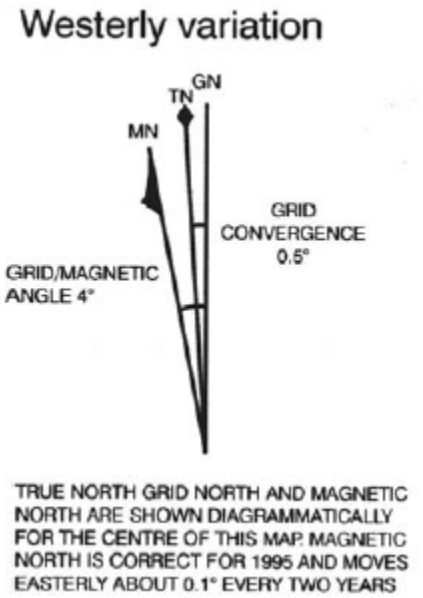
North points

Calculating the grid magnetic angle for 2003

Example:

The number of years elapsed since the diagram on the left was correct is: 2003 – 1991 = 12 years, and as the annual change is easterly by 0.1° every 3 years, then 0.4° must be added to the 1991 grid magnetic angle: 14.5° + 0.4° = 14.9°.


Easterly variation
TN
GN
MN
GRID CONVERGENCE 0.5°
GRID/MAGNETIC ANGLE 14.5°
TRUE NORTH GRID NORTH AND MAGNETIC NORTH ARE SHOWN DIAGRAMMATICALLY FOR THE CENTRE OF THIS MAP. MAGNETIC NORTH IS CORRECT FOR 1991 AND MOVES EASTERLY ABOUT 0.1° EVERY THREE YEARS


Westerly variation
TN
GN
MN
GRID CONVERGENCE 0.5°
GRID/MAGNETIC ANGLE 4°
TRUE NORTH GRID NORTH AND MAGNETIC NORTH ARE SHOWN DIAGRAMMATICALLY FOR THE CENTRE OF THIS MAP. MAGNETIC NORTH IS CORRECT FOR 1995 AND MOVES EASTERLY ABOUT 0.1° EVERY TWO YEARS

Activity 25

From the diagram on the map provided by your Trainer, calculate the magnetic variation you need to use to convert bearings.

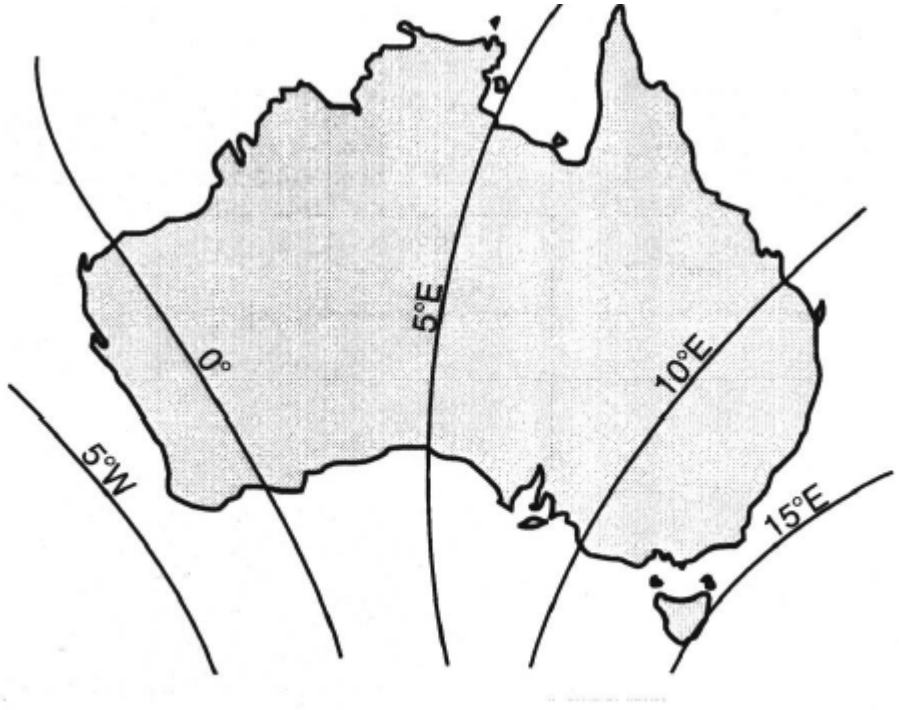
_____

Conversion of Bearings

Compass bearings taken on the ground must be converted to grid bearings for plotting on a map. Conversely, grid bearings taken from a map will have to be converted to magnetic bearings before they can be used with a compass on the ground.

To convert a bearing from grid to magnetic or magnetic to grid is a simple matter of adding or subtracting the magnetic variation. Unfortunately, the magnetic variation across the continent of Australia is not constant; the majority of the country is subject to easterly variation of up to 15° but the western part of Western Australia has a westerly variation of up to 4° (see Diagram below).

It becomes easy to make a mistake and add when you should subtract, or subtract when you should add. Therefore, the only safe way to avoid this is to draw a rough diagram based on the relationship between grid and magnetic north (as depicted in the map's north points diagram) and the required bearing.

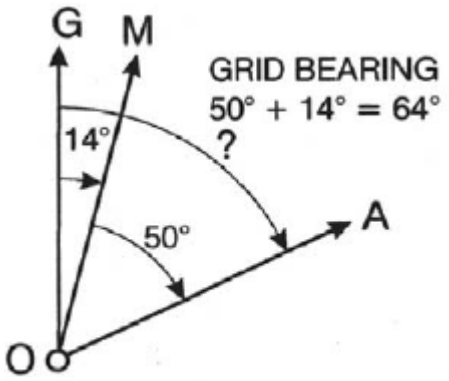


Magnetic variation across Australia

Conversion of bearings easterly variation

Example 1 (see Diagram):

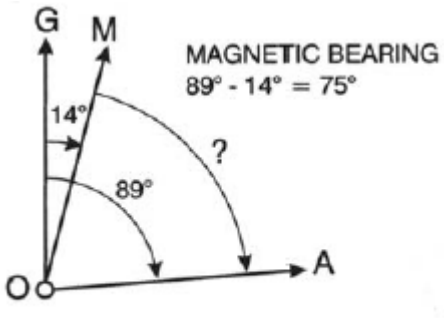
A magnetic bearing of 50° is to be converted to a grid bearing. The magnetic variation is 14° east. So 50° + 14° = 64° which is the grid bearing.



Easterly variation

Example 2 (see Diagram):

A grid bearing of 89° is being converted to a magnetic bearing. The magnetic variation is 14° east. So 89° - 14° = 75° which is the magnetic bearing.

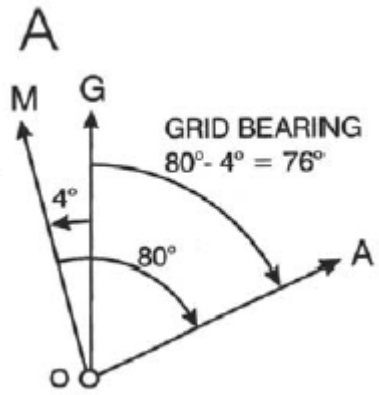


Easterly variation

Conversion of bearings westerly variation

Example 1 (see Diagram A):

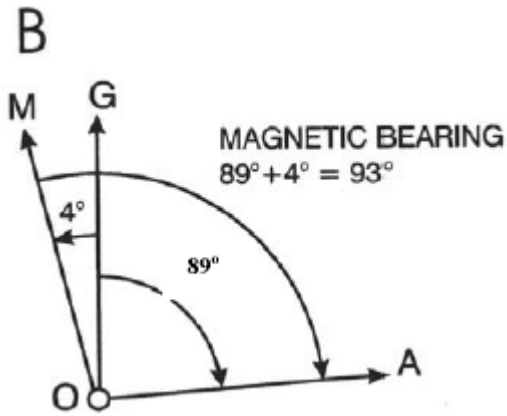
A magnetic bearing of 80° is to be converted to a grid bearing. The magnetic variation is 4° west. So 80° - 4° = 76° which is the grid bearing.



Conversion Magnetic bearing to Grid bearing – westerly variation

Example 2 (see Diagram B):

A grid bearing of 89° is to be converted to a magnetic bearing. The magnetic variation is 4° west. So 89° + 4° = 93° which is the magnetic bearing.



Conversion of Grid bearing to Magnetic bearings – westerly variation

Activity 26

Using map information provided by your trainer, calculate the change in magnetic variation over a given timeframe. From this information calculate the magnetic bearing between two given locations.

SESSION 7 – USING THE COMPASS

Learning Outcomes for this session:

- State how to use a Prismatic compass
- Demonstrate how to take a bearing with a Silva compass
- Demonstrate how to set a bearing on a Silva compass
- Demonstrate how to maintain direction using a Compass
- Demonstrate how to plot bearings on a map using a Silva compass
- Demonstrate walking a back bearing using a Silva compass
- Demonstrate how to negotiate an obstacle using the Silva compass
- Explain how to care for and maintain the equipment.

COMPASSES

A compass is a device that can be used to find the direction from one point to another, this is essential when you are working as part of a search team or mapping a route for construction of a dozer line, this can be done in the field or on an map. There are many types of magnetic compasses suitable for use in map reading and navigation. Although they may differ in shape and size, the principle of operation is essentially the same. In brief:

- Magnetic compasses work on the principle that the pivoting magnetised needle, or the north point of the swinging dial to which it is sometimes attached, always points to magnetic north. Thus, a compass with graduations (degrees) marked on it can be used to measure the bearing of an object from Magnetic North.

- On the compass housing is a datum point (north) and sometimes an aiming point or protrusion along the same line. To take a bearing, simply rotate the compass until the aiming point or datum point is in the direction of the object. To read the bearing, read the angle shown between the needle and the datum point either from the swinging dial or the graduations on the compass body.

Prismatic Compass

The operation of the prismatic compass is similar to that described above. The box of the prismatic compass is filled with liquid to dampen the movement of the card so it rotates gently and comes to rest quickly. A card, graduated in degrees, is usually fixed to the top of the needle with the 360° mark directly over the north point of the needle.

The compass is held in a steady position, in both hands with a thumb through the ring, the lid vertical and the prism turned over in the reading position. Looking through the prism line up the object with the hair line in the centre of the prism slot and read off the bearing on the card against the hair line.

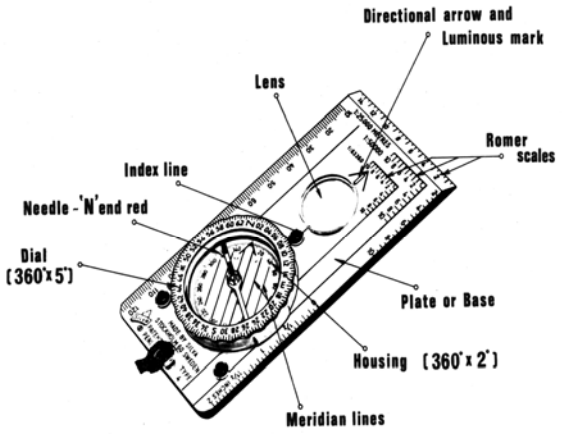
It helps if your hands or elbows can be rested against a wall or some other nonferrous object.

Some clear plastic compasses can be used in ways similar to the prismatic as the user sights through a lens and lines up a hairline on the object to which the bearing is required.

Silva Compass

The Kjellstrom brothers developed the Silva compass in Sweden during the 1930s. Although initially designed for the sport of orienteering, the compasses are now used widely throughout the world by emergency services and many other organisations as a general-purpose compass.

Although other manufacturers now produce similar rigid, clear plastic compasses, the name 'Silva' will be used as a generic name in this learning resource to describe this type of compass.



There are many different types of Silva compasses available. However, the basic construction for all types remains the same. The compass enables the user to plot and calculate bearings rapidly and accurately on a map without the use of a protractor by combining, on a common base plate, both a compass and a protractor.

The diagram above shows the major components of the type 4 compass, a popular type originally designed for use by the British Army.

Using the compass

Because of its unique design, the Silva compass is very simple to use. The major applications and uses of the compass are detailed in the following paragraphs.

To take a grid bearing:

The procedure for calculating a grid bearing from a map is as follows (refer to the diagram on the following page):

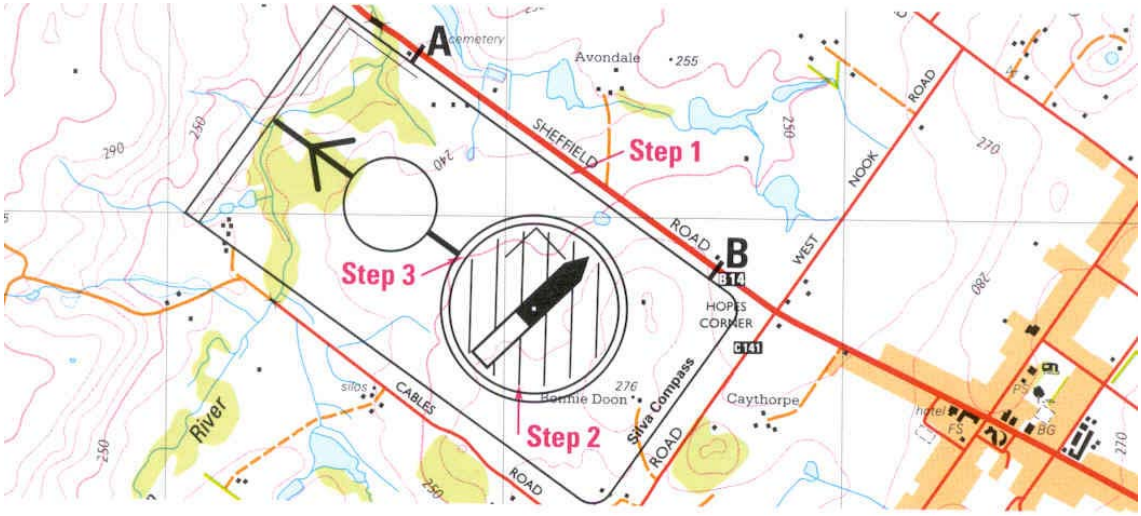
Step 1 Place the long edge of the compass plate along the desired bearing (along line AB in the diagram below) making sure the direction arrow on the compass plate points in the direction you wish to travel.

Step 2 Turn the compass housing so that the meridian lines are parallel with the Eastings on the map, and the meridian arrow points north

Step 3 Read the grid bearing on the housing where the index line intersects it.

Note

The bearing that has been calculated is a grid bearing. This bearing must be converted to a magnetic bearing if it is to be set on the compass.



"Image supplied by TASMAP"

Activity 27

Calculate grid bearings using the Silva compass from grid references provided by your Trainer.

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_____

_____

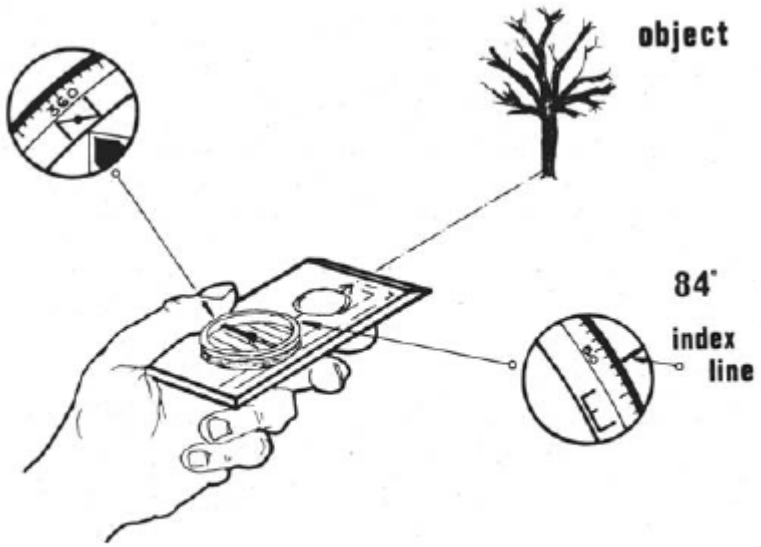
To take a magnetic bearing:

The procedure for taking a magnetic bearing to an object is detailed below.

1. Hold the compass flat in the palm of the hand, in a horizontal position, with the direction arrow pointing to the object.

2. Rotate the compass housing until the red meridian arrow is directly beneath the red (north) end of the compass needle.

3. Read the magnetic bearing on the housing where the index line intersects it.



Taking a magnetic bearing (Silva compass)

Setting the compass to walk on a magnetic bearing:

7. Set the magnetic bearing on the compass by rotating the compass housing until the required bearing is in line with the index line on the compass plate.

8. Holding the compass level in the palm of your hand, turn around until the red end of the compass needle points to the meridian arrow on the compass housing and is parallel to the meridian lines.

9. The direction arrow now points along the required magnetic bearing.

For night movement:

Some compasses have luminous marks, such as the needlepoint, two dots on the compass face and the index line and directional arrow, and can therefore be used when navigating at night.

Line the needlepoint between the two dots on the compass face and walk on the index line and directional arrow.

Shine a torch on the luminous settings if the compass is difficult to read.

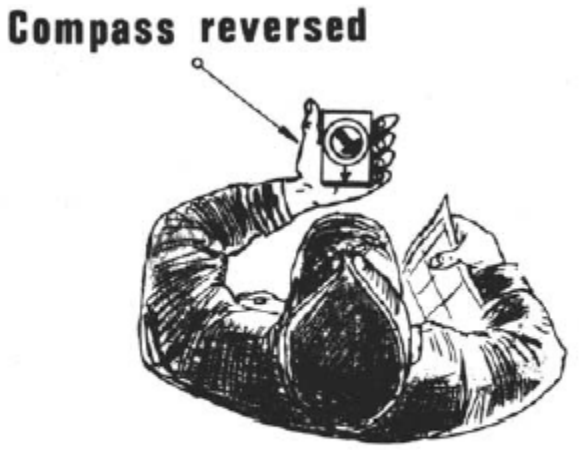
Maintaining Direction Using A Compass

When moving through dense vegetation it is important that continuous checks be made using the compass.

- The best method for maintaining a given magnetic bearing is to select a prominent object (such as a tree), which lies on the bearing, and move to it.
- Then select another object on the bearing and move to that.
- Continue with this method until the destination is reached.
- If it is impossible to find a prominent object on the bearing, send another person forward a visual distance, correct this person onto the bearing and then proceed to them.
- Repeat this procedure until the destination is reached.
- In a larger team, 'leap frogging' of personnel can be beneficial to the continuous movement of the team. In this instance, send out one or two marker personnel, the second traveling further, ready to be aligned when the team arrives at the first point.

Back bearings:

Unlike most other types of compasses, there is no requirement to calculate back bearings with the Silva compass. If you are marching on a given bearing and wish to return to your original start point, simply turn around to face roughly in the direction from which you have come and reverse the compass so that the direction arrow points towards you (see Diagram). Orient the compass by turning its whole body until the red end of the compass needle points to the north point on the housing and march in the direction in which the back of the compass plate faces.

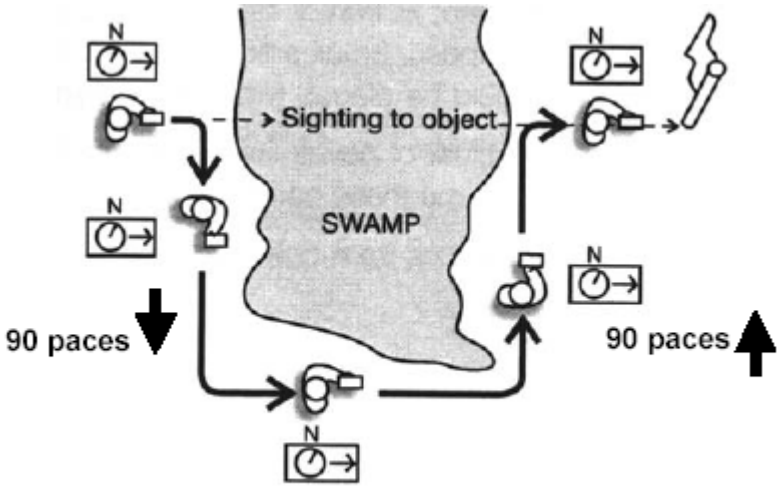


Back bearings (Silva compass)

Altering direction to avoid an obstacle:

There may be occasions when it will be necessary to alter the direction of travel in order to avoid a major obstacle. Traveling around the obstacle by a series of right angles best does this. To carry out this manoeuvre with most compasses it necessitates altering the compass setting by 90° each time a change in direction is required. With the Silva compass this can be done without any alterations to the original compass setting simply by taking advantage of the right angles of the compass plate and sighting along its short edge as shown in the diagram below.

Note: Pacing must be maintained throughout the manoeuvre.



Avoiding an obstacle (Silva compass)

Compass Errors

When using a magnetic compass, you should be aware of the two main causes of variation in compass readings.

Individual compass error

- Each compass has its individual variation, that is, it does not point exactly to Magnetic North. This error may be negligible or comparatively large and therefore it is important to have compasses checked regularly and this variation allowed for when used.

Local magnetic attraction

- Local magnetic attraction is due to the presence of iron or iron ore nearby. The compass is a delicate instrument and quite small quantities of iron have a surprisingly large effect on its behaviour. A wristwatch or steel-framed spectacles will affect the compass reading.

- Take the precaution of seeing that all iron or steel objects are at a safe distance before using the compass. Small articles will be safe in your pocket but larger articles should be placed two or three metres away.

- Remember also to keep well clear of power lines, wire fences, vehicles and railway lines when using a magnetic compass.

- Listed in Table below are safe distances from common objects.

COMMON OBJECTS	SAFE DISTANCES
Transmission high tension lines	80 metres
Large vehicles	75 metres
Car/utility	60 metres
Fencing wire/concrete	10 metres
Pick axe or shovel	3 metres

To check for local magnetic attraction:

1. Select two points about 100 m apart.

2. From one, take a bearing to the other.

3. Then move to the other and take a back bearing to the first.

4. The two bearings should differ by 180° (back bearing). If they do not there is a magnetic disturbance at one point or the other or at both.

Care of the Compass

At the completion of activities, all equipment should be made ready for storage. Maps should have all pencil marks erased and be folded correctly and placed in tubes or a map drawer. Compasses should be stored in a soft pouch, and lay flat, away from metal surfaces. A soft spectacle case is ideal for storing a compass.

The life of the compass can be prolonged by careful use by:

1. Keep it out of sunlight when not in use;

2. Avoid extremes of heat and cold which could affect the liquid inside the housing;

3. Prevent concussion to the instrument (e.g. do not drop it or knock it against hard objects) as the housing seal may become damaged – if an air bubble develops inside the housing, the compass is faulty and should not be used, and

4. Keep it free from dirt as sand particles around the housing will erode its surface and eventually cause the housing to rotate too easily, making it difficult to keep on a set bearing.

Always check before use that the housing is free of bubbles, that the cord is in good order, and that any other attachments are functioning properly. Keep in a pocket during use to avoid snagging, knocking it on objects and too much unnecessary contact, which can erase the figures on the compass face.

SELF CHECK

	YES	NO
Did you understand the activity/activities you were asked to do?		
Did you have enough time to complete the activity/activities?		
Can you use a protractor to take and plot a grid bearing?		
Can you calculate changes in magnetic variation over a given time frame?		
Can you calculate magnetic bearings between given locations?		
Using the Silva compass, can you determine magnetic bearings of given landmarks?		
Can you calculate back bearings?		
Can you check a compass for local magnetic attraction?		
Can you use a compass to alter direction to avoid an obstacle?		

- If you have answered YES to all of the questions above, you are ready for the next topic.
- • If you have answered NO to any question, ask your trainer for help.
- • If you don't feel confident with an activity, you may want to go back and review it.

NAVIGATE IN URBAN AND RURAL ENVIRONMENTS

SECTION FOUR

NAVIGATION AND PLANNING

Element	Performance Criteria
2. Determine and plan a safe route	2.1 Navigation records are prepared in accordance to organisations practices. 2.2 Cartographic information, navigation techniques, local and environmental conditions are interpreted to determine and plan a safe route. 2.3 Potential access restrictions, which may limit thoroughfare, are identified and arrangements made to gain access in accordance with organisations policies and practices and regulatory requirements.
3. Navigate to destination.	3.1 Record of proposed route and navigation aids are used to maintain compliance with planned route. 3.2 Driver is directed to follow indicated route as required. 3.3 Current location is regularly verified within accepted tolerances. 3.4 Route is modified to address prevailing conditions and, if required, alternate strategies are initiated. 3.5 Lost en-route procedures are implemented if required. 3.6 Unanticipated access difficulties are reported in accordance with organisation's policies and procedures. 3.7 En-route and arrival reporting is communicated in accordance with organisation's policies and procedures.
4. Complete post-navigational activities.	4.1 Navigation or nominated reports are completed in accordance with organisation's policies and procedures. 4.2 Navigational equipment is recovered, reset, updated and serviced according to operational standards and manufacturer's specifications.

SESSION 8 – NAVIGATION ACROSS COUNTRY

Learning Outcomes for this session:
- Explain planning considerations for a cross-country walk
- Demonstrate how to find north using a watch
- Prepare a navigation data sheet.

NAVIGATING ACROSS COUNTRY

Rugged terrain and dense vegetation can impose additional difficulties on cross-country navigation. In thickly timbered areas, visibility is often reduced to 25 m or less and there will be few recognisable landmarks. Bad weather with low cloud, mist, rain or snow can occur, requiring reliance on map and compass for cross-country navigation.

The purpose of this topic is to detail important points that will assist with cross-country navigation.

NAVIGATION AIDS

If you rely on map reading ability alone, without using navigational aids, you will ultimately have navigation difficulties. This is especially the case in featureless country, in thick vegetation or in poor visibility. The more common aids you can use may be divided into those for position finding, direction finding and distance traveled.
These are:

- Maps
- Aerial Photographs
- GPS
- Magnetic Compass
- Sun and Analogue Watch
- Improvised Compasses
- Stars

Position Finding:

Maps

A map is the single most important navigational aid and as such should be carefully studied before and during navigating to cross-country. This study will provide the answer to many questions, such as the best route to be taken and areas to be avoided. It also enables you to visualise the lie of the land, to assist your sense of direction and to increase your confidence.

Aerial photographs

Aerial photographs provide a valuable check to map reading, when they are available.

GPS – Global Positioning System

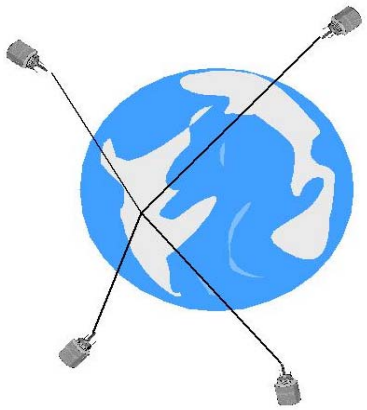
The Global Positioning System is a worldwide radio-navigational system that uses a network of 24 satellites and their ground stations to calculate position. Reference points can be accurate to a matter of metres.

The GPS device, usually a hand held receiver, is only an aid to navigation. The navigator must accurately enter data into the receiver for it to be of any use. It should never be relied on to do all the navigating for you.

GPS Functions

Some of the general functions of a GPS receiver are:

- Determine ground speed;
- Plot current position;
- Store your current position as a waypoint;
- Store other positions as waypoints;
- Plot routes traveled;
- Calculate a bearing between the two positions;
- Determine an error left or right of your intended track;
- Determine a range or distance between two positions.



Navigation

Navigation with a GPS receiver is similar to navigating with a compass in that a map is required with both methods. Map reading and navigation skills are vital, and the need to plan the route to be traveled still exists.

A map and compass should be carried at all times when using GPS in remote areas as the receiver is powered by batteries, which may fail with prolonged use, and other prevailing conditions may interfere with the GPS performance.
These conditions include:

- Cloud cover
- Electrical storms
- Thick vegetation interrupting clear view of the sky
- Operating inside a building or shed
- Operating in gorges, caves, mines or features that obliterate the sky
- Operating inside a vehicle without external GPS antenna

Most commercial GPS are accurate to within 50 metres horizontally or 70 metres vertically and therefore are adequate for emergency service use. GPS receivers can be programmed to display latitude and longitude readings, or grid references. The Universal Grid Reference System is used to display grid references. Check the User's Manual to determine how to read six figure grid references, and set other essential data required for accurate GPS readings.

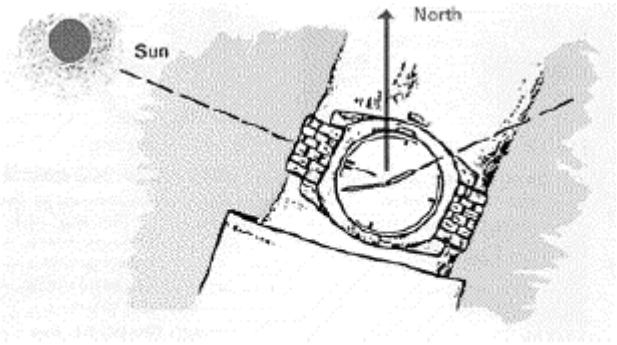
Direction Finding:

Magnetic compasses

The compass is a valuable aid to cross-country navigation, particularly when moving at night or through dense vegetation where it is difficult to identify recognisable landmarks.

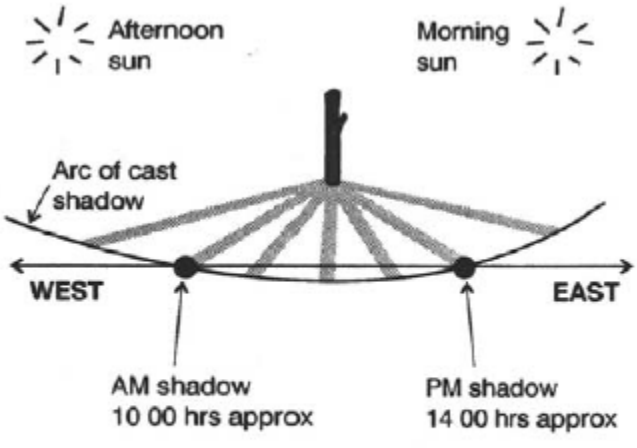
Sun and analogue watch

If the sun is visible, point the figure 12 on a watch towards the sun, then true north is approximately halfway between the 12 and the hour hand.



Analogue watch Method

This method, illustrated above, is suitable only in the South Temperate Zone. In the tropics an east-west line may be established by observing the movement of a shadow cast by a vertical stick on a flat surface over a period of 4 to 6 hours about midday illustrated below. The watch must be set to standard time (not daylight saving) for both methods.



Direction finding – shadow stick method

Improvised compass

Take a needle or piece of wire and stroke it against silk or a magnet if you have one, in one direction only. This will magnetise it. If you then suspend it from a piece of string it will point north. It can also be placed on piece of paper or a leaf in a bowl of water, giving you the same result.

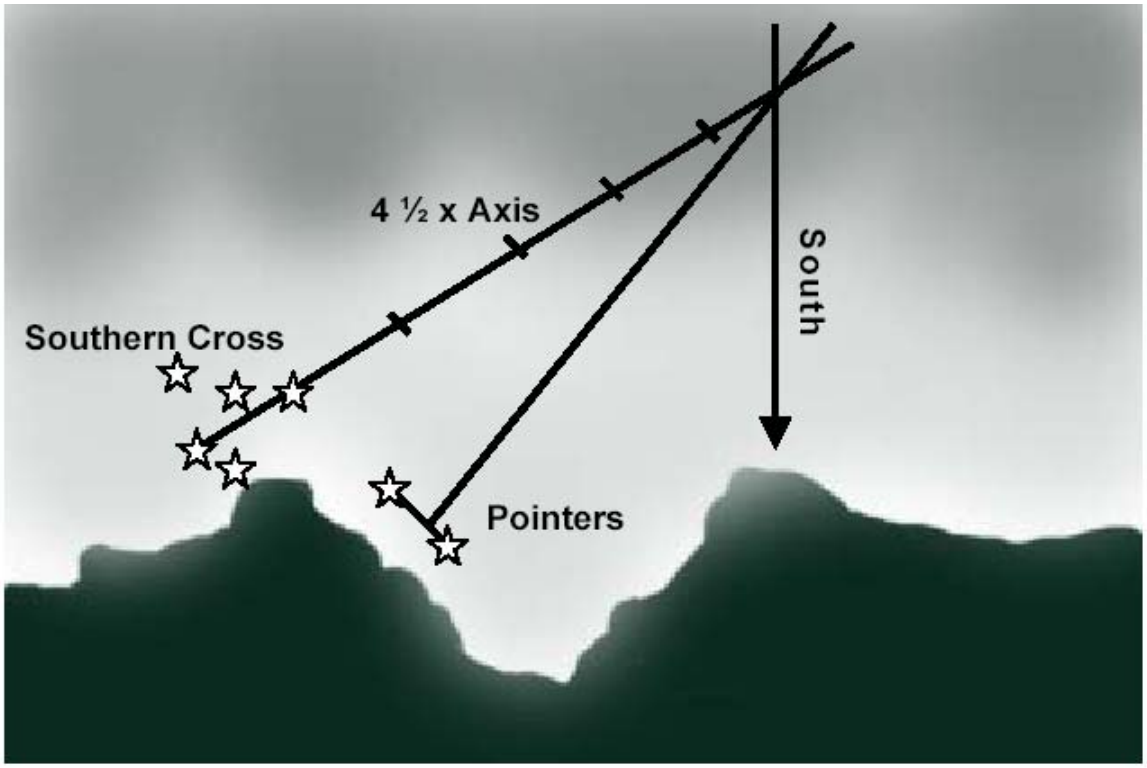
With The Southern Cross And The Pointers Visible

Method 1.

If the stars are visible, extend the long axis of the Southern Cross from its tail by 4 1/2 times its length; this point is almost directly above true south.

Method 2.

Draw an imaginary line to join the two Pointers and then bisect that line with another at right angles to it. The direction of the South Pole will then be the intersection of that line and that which is a prolongation of the long axis of the Southern Cross.



Finding south – using the Southern Cross

Navigation Under Special Conditions:

Navigating can be very difficult and you may face extreme conditions. The weather may be overcast and you can experience low cloud, which will give reduced visibility in the higher altitudes. Snow may be present which changes the appearance of the landscape, even thick vegetation after re-growth from a bushfire may present a difficulty. Southern slopes will be wetter and more slippery whereas the northern aspect will be drier and more exposed. You need to factor all of these potential conditions into your planning when navigating.

Thick Vegetation i.e. Wet Sclerophyll Forest.

Close country navigation is characterised by limited visibility and a slow rate of movement, thick vegetation often prevents the distinguishing of landmarks. Any track or road marked on a map should be treated with suspicion before using it for searching. Quite often, tracks may be overgrown while others are created particularly with 4WD movement. Consequently, recent air photos should be used in navigational planning whenever they are available.

The most reliable method of navigation is by continuous reference to the compass and by pacing. A navigational party must be nominated and, if necessary, a group average should be used to derive the distance traveled. Measured bearings must be strictly followed and the tendency to veer randomly towards easier going should be avoided. If obstacles have to be bypassed, the route must be deliberately plotted and measured.

Desert Conditions.

As most long moves in the desert are conducted in vehicles, a magnetic compass is only reliable if the navigator continually dismounts to take bearings because of the magnetic interference. As this normally makes movement unacceptably slow, Global Positioning Systems (GPS) may have to be used.

From a Vehicle – Roads and Cross-Country.

A vehicle is normally restricted to roads and tracks except in open areas because of the risk of bogging and puncturing of tires. In some instances, the roads can be of assistance to navigation, but they are often misleading and cause most navigational errors. Because the distance is covered at a much faster rate in a vehicle than when walking, the ground cannot be examined in detail.

Planning

It is essential that, before setting off on a course, detailed planning be carried out. Particular aspects that should be undertaken are outlined in the following paragraphs. Proper planning can alleviate the chance of anything going wrong, and if the inevitable happens you know where you have come from and are able to re trace and counteract any problems. Know where you are going, and why, what is your objective and what are you trying to achieve. This all needs to be documented as there may be lesson which you can improve or learn from.

Map Study

This was mentioned previously as the essential preliminary to planning. In deciding the best route from one point to another, the following factors should be considered:

FACTOR	CONSIDER THE FOLLOWING
Grain of the country	➢ It is physically easier to follow the grain of the country than to go against it, therefore, a direct route in the form of a straight line is practical only in relatively flat, open country. ➢ There is minimal grain of the country in mountainous terrain.
Ridges	➢ The vegetation along ridges is generally less dense than in valleys. ➢ In addition to this, there are often animal tracks making it is easier to travel on ridges rather than in valleys. ➢ Ridges provide useful observation of surrounding landmarks.
Rivers	➢ While rivers are useful aids to direction keeping, it is generally not wise to follow them because in rugged country they are winding and usually bordered by dense vegetation.
Close country	➢ Movement in this environment is slow and there is a tendency to over-estimate distance traveled. ➢ Visibility is limited and the size of features traversed is also over-estimated. ➢ Unless experienced, the navigator in close country should follow the most direct compass route rather than navigate from feature to feature.

Checking

Once a course commences, checking of direction and distance, as outlined in previous paragraphs, must be continuous. Additional areas requiring particular attention are covered below:

- All features, hills and rivers should be checked as they are reached and identified on the map. Note the direction of flow of all streams and rivers and check with the map.

- Tracks should be identified but should always be regarded with suspicion. It is easy to place too much confidence in a track which may not be the one marked on the map. The same applies to any manufactured feature, especially in dense vegetation.

Actions If You Become Lost

If lost, you should not act hastily. You should stop and consider:

- Whether you have drifted left or right of your line;

- Whether you could have already passed the objective, or whether the time and distance traveled was badly estimated;

- Whether the ground covered conformed with your mental picture of what you expected from the map;

- Whether there are any features in the area which will help you to fix the position, or enable you to conduct a resection;

- The possibility of local magnetic attraction, compass error or map inaccuracy in the map, although extreme care should be taken before attributing your being lost to the map.

As a result of careful consideration, it should be possible to narrow the situation down to two or three probable locations. A short reconnaissance in opposite directions should provide sufficient information to allow a fix of your position.

Leaders must always brief their groups on the action to be taken if they become separated from the group. The brief must be kept simple and the action required should remain the same for all legs of a route.

If groups are told to move in specific directions when lost, it should be worded in terms of north or south, rather than left or right, as direction can then be found with only a basic knowledge of the movement of the sun and stars. For example, move east to the railway, and then follow it south.

Please Note:
If you become lost it is important that you follow your chain of command and notify your Incident Controller or Comcen, so someone is aware of your situation.

Potential Access Restrictions

At times a team may find its movement restricted by one means or another. Sites of significance or importance, private property, National Parks, recreation areas, military facilities, and in some cases, firing ranges, may have restricted or 'authorised personnel only' access limitations on them.

Under the new ESA legislation, these access restrictions are **diminished, providing the team is acting in good faith in relation to a disaster and the task it has been assigned**. If a locked gate is found which prevents access follow your chain of command or notify Comcen of your actions. It would be wise however to contact the Incident Controller for further approvals before entering any restricted access area such as the Majura Road Firing Range.

In the case of training or exercise activities, which are planned well in advance, it is organisational protocol to make contact with the property owners, preferably in writing, a few weeks prior to the activity to seek permission to enter and use the land. The Land management agencies have local protocols for any activities taking place on their land and permission needs to be granted before the exercise occurs. If your brigade is planning an activity such as familiarization of a reserve, you must apply for the approval as a brigade/unit and notify HQ of your actions.

Activity 28

Explain the process of gaining access to restricted areas.

a) On training exercises

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b) On operations

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Navigation Data Sheet (Route Card)

Before commencing a course, the route to be taken should be divided into legs (or segments) and marked in pencil on the map. These legs should terminate at some easily recognisable object not more than one hour's walk apart. Having done this the next step is to produce a navigation data sheet or route card for the complete route.

This sheet, illustrated below, gives the significant information required for each leg of the overall route. This then becomes a ready reference and is of great value.

Navigation Data Sheet

Leg	From GR	To GR	Mag Bearing	Distance (metres)	Est Time (mins)	Pacing count	Going	Remarks
1	111459	121464 dam	50	1100	15		a. Gentle rise in open country	Creeks at 700m and 800m
2	121464	122475 building on track	352	1100	15		a. Undulating ground sloping R to L through scattered timber	Creek at 800m
3	122475	114474	248	820	10		a. Gentle fall through scattered timber b. 300m open	
4	114474	111459 "Malmac Homestead	178	1520	25		a. 1100m gentle down hill, open b. 100m steep rise through med timber c. 300m down hill, open	Creeks at 250m, 700m, 1000m, and 1400m Road on ridge at 1200m

Activity 29

List factors to be considered when planning a cross-country navigation walk.

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_____

Activity 30

Prepare a navigation data sheet from information provided by your Trainer using the blank navigation data sheet in the appendix.

SESSION 9 - PACING, JUDGING DISTANCE.

Learning Outcomes for this session:

- Calculate your pacing distance over 100 metres
- Estimate distances with reasonable accuracy to a determined object
- Locate features on the ground and locate the same features on the map.

Distance Traveled

It is very important, particularly when moving through vegetation, to know the distance that has been covered. The two basic methods for achieving this are described below.

Pacing

This is generally accepted as being the more reliable method. Distance can be counted in number of paces, which for the individual can be translated into kilometer's, depending on the type of country and the average length of the pace.

To determine stride length, mark out a distance of 100 metres on flat ground. Walk this distance at least three times, counting either left or right foot only, or both feet. Take the average count of the three walks as your average stride for 100 metres in flat terrain. Repeat the process going uphill, and downhill, as length of stride varies with slope.

To help keep count, use small pebbles or seeds and transfer these from one pocket to another at each hundred metres. Toggles or a specialised pace counter can also be used, but beware of metallic interference when using the compass.

The following is an example of how pacing is calculated during navigation:

- When pacing, you should measure off in 100 metre units up to 1 km and then reassess your position. For a 76 centimetre (30 inch) pace, approximately 657 right footpaces will equal 1 km. When estimating distance from the map, allow for the rise and fall of the ground. Where the measured distance on the map is 1000 metres, it will only be accurate if the ground is flat. If there is a hill included in the 1000 metres, its height will have to be taken into account and the pacing count adjusted for climbing it on one side and going down the other.

Activity 31

Your trainer will mark out a hundred-metre distance. You are to pace the distance three times and record your average walking stride.

_____

This activity should be done on flat ground and on sloping ground.

Time

Distance can also be calculated from the time in relation to speed of walking in kilometre (km) per hour. For the average person walking over fairly flat country, a 76 cm (30 inch) pace will result in a speed of about *5* km per hour.

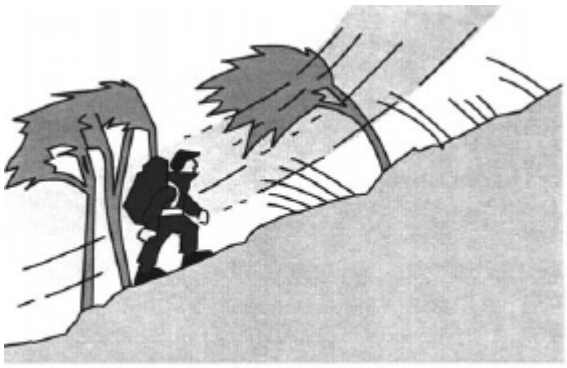
Predicting Walking Time

A rule for predicting walking time in Australian conditions is as follows. For an average walker carrying a medium pack allow one hour for:

- Every 5 km of easy going
- Every 3 km of easy scrambling
- Every 1½ km of extremely rough country, deep sand, soft snow or thick bush
- Plus one hour for every 500 m up and one hour for every 1000 m down.

For every five hours, include up to one hour to allow for fatigue.

Factors influencing walking time include tiredness, weather, steep ground, conditions underfoot, use of a rope, using ski poles, inappropriate use of crampons (spiked iron plates on the bottom of shoes that stop you from slipping), poor navigational skills, poor route choice, fitness, and nothing to sight on being lost.



Factors influencing walking time

Methods of Judging Distance

The four common methods for judging distance are described below.

Unit of measure method

This consists of taking a distance with which the viewer is familiar (e.g. the length of a swimming pool or sports field) as the unit and seeing how many units can be fitted in between the viewer and the object. This method may be used for distances up to 400 m provided the viewer can see all the ground between the viewing point and the object.

Appearance method

Using this method the viewer judges the distance to an object by comparing its size with that of its surroundings. It takes much practice to become expert but under certain circumstances this method can prove extremely valuable.

Bracketing method

With this method the viewer decides on a minimum and maximum distance that the object could be from the viewing point and then takes the average between the two distances. For example, it may be decided that a particular object is more than 200 m away but less than 600 m. Therefore the distance, in this case, is estimated to be 400 m.

Group Average Method

When a team of personnel is together, the team leader asks each member to estimate the distance to the object. The average of these estimations is then taken as the distance. If team members are well practiced in judging distances, this method is reasonably accurate.

Activity 32

Your trainer will set up a field exercise by placing or nominating specific objects in a defined area. You are required to nominate the distances from you to each of the objects.

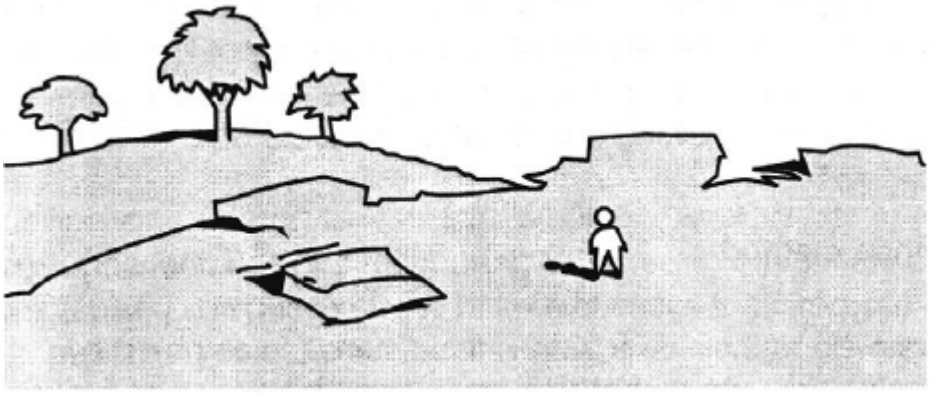
_____

_____

Conditions that affect judging distance

Objects seem closer than they really are when:

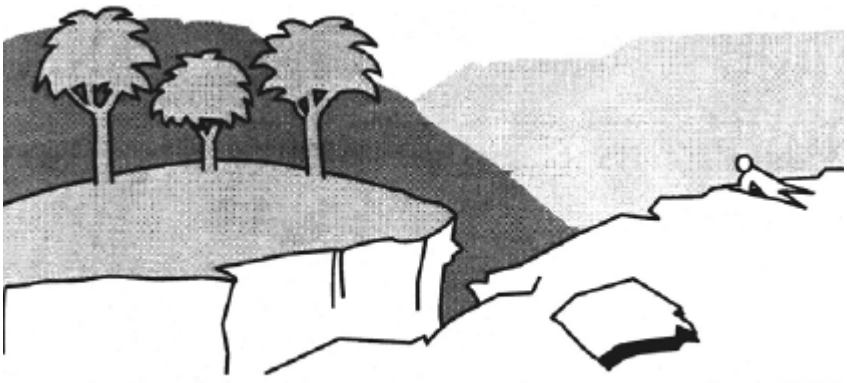
- The light is bright or the sun is shining from behind the viewer
- They are bigger than other things around them
- There is hidden ground between them and the viewer
- They are higher up than the viewer is.



Object seems closer

Objects seem farther away than they really are when:

- The light is bad or the sun is in the viewer's eyes
- They are smaller than other things around them
- The viewer is looking across a valley or down a ravine or creek
- The viewer is lying down
- The object is against a dark background.



Object seems farther away

Activity 33

From the map provided, your trainer will ask you to locate various land features from the map that are visible on the ground.

_____

_____

SESSION 10 – POSITION FINDING BY RESECTION

Learning Outcomes for this session:

- Demonstrate two methods of orientating the map
- Demonstrate how to perform a resection.

Map Setting and Position Fixing

A map is said to be 'set' or orientated when the features on the map are in the same relative position as the features on the ground. There are two methods for setting a map:

By inspection

This is the simplest and quickest method of setting a map. The procedure is to select objects on the ground that can be identified on the map. Turn the map so that the objects on the map are lined up with those on the ground. The map is now set or orientated.

By compass

This is by far the most accurate method of setting a map and should be used when it is difficult to identify sufficient detail on the map and on the ground. Place the compass on the map over the magnetic variation diagram with the compass axis along the magnetic north line of the diagram. Rotate the map and compass until the north point of the compass needle points directly along the axis line of the compass.

Position Fixing/Compass Resection

The following procedure can be used to fix your position when you can recognise features on the ground and on the map but are unable to fix your exact position on the map:

1. Select three prominent, widely spaced features that you can recognise on the map and on the ground. Two features can be used to get an approximate position.

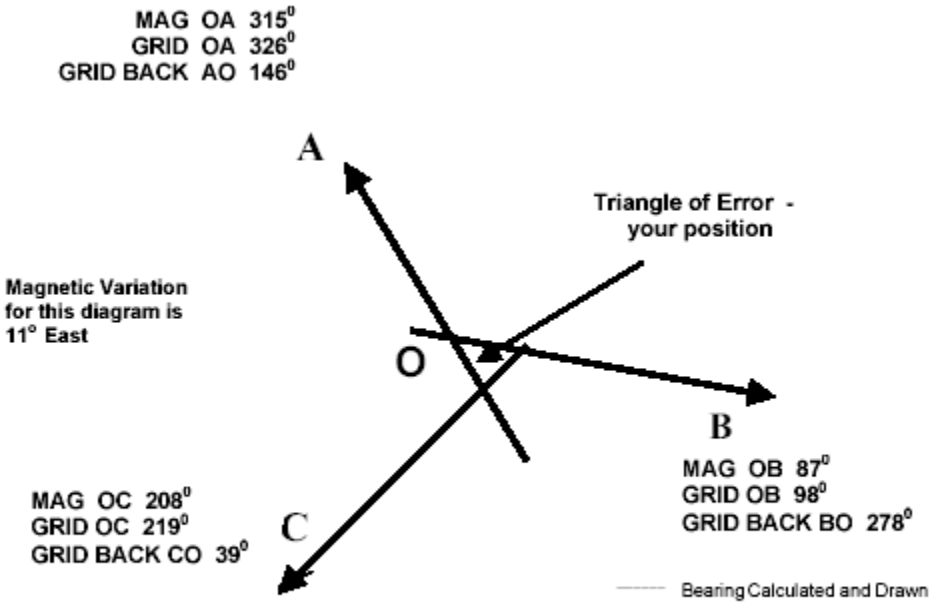
2. Using the compass, take a magnetic bearing to the first feature.

3. Convert the magnetic bearing to a grid bearing.

4. Convert the grid bearing to a back bearing and plot this back bearing on the map with a thin line from the feature.

5. Carry out the above procedure until you have plotted the back bearings on the map from each of the features you have selected.

6. These lines will either intersect to locate your position or form a small triangle of error. It is called the 'Triangle of Error'.



Resection - Triangle of error

Activity 34

In an area defined by your trainer, orientate your map using

a) The inspection method _____

c) The compass method _____

Activity 35

Your trainer will ask you to practice resection in the field.

SELF CHECK

	YES	NO
Did you understand the activity/activities you were asked to do?		
Did you have enough time to complete the activity/activities?		
Can you prepare a route card?		
Can you orientate the map to north in the field?		
Can you conduct a resection?		
Can you maintain direction using a compass?		
Do you know what to do if you become lost?		

- If you have answered YES to all of the questions above, you are ready for assessment.
- If you have answered NO to any question, ask your trainer for help.
- If you don't feel confident with an activity, you may want to go back and review it.

Appendix 1

Navigation Data Sheet

Localise data Sheet

Leg	From GR	To GR	Mag Bearing	Distance (Metres)	Est. Time (mins)	Pacing Count	Going	Remarks
1								
2								
3								
4								